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SOUTH AFRICA AS A LAND OF OPPORTUNITIES.

By Robert Wallace.

THE area to which attention is directed is that great section of Southern Africa which lies to the south of an imaginary line drawn somewhere to the north of the eighteenth meridian of south latitude and corresponding for some distance with the course of the river Zambesi. In the extreme south we have Cape Colony; in the northwest, German West Africa; in the east, the British colony of Natal, the two Boer republics, (the Orange Free State and the Transvaal), and the southern extremity of the Portuguese possessions; and, in the center and to the north, Bechuanaland and southern Rhodesia, the latter of which was formerly designated Matabeleland and Mashonaland. The great backbone of this part of the African continent is the Drakens Bergen range of mountains, running up to heights of more than ten thousand feet in some places, and not occupying a central position, but lying at a distance of from one hundred to one hundred and fifty miles inland from the east coast. A continuation of the range forms the most northerly and the most elevated of three mountain ranges which traverse the southern portion of Cape Colony in lines running east and west. Being at different elevations with the general land surface to the north at a higher level in each case, they have been aptly likened to a stair of three steps, by which the great and somewhat irregular central plateau forming the greater portion of the area may be approached from the south.

The general elevation above the sea may be roughly stated as varying from four thousand to six thousand feet. Johannesburg stands on one of the highest sections of this vast plain, and the surface falls

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away gradually and irregularly, as may be seen by following on a map the direction of the rivers towards the west, where it is bounded by the west coast range of mountains in the German territory, and to the north, where it drains into the river Zambezi. The monotony of view is broken in places by "kopjies," or low, flat-topped hills formed of the remnants of rock strata which have escaped the weathering influences that led to the denudation and lowering of the surface surrounding them, or of basaltic rocks which have been obtruded in past ages by volcanic action. The geological and land surface appearances of South Africa are unique, and display features characteristic of that country. While volcanic action in remote periods has been wide-spread, it has been more local than general, and immense areas exist where the strata remain undisturbed, and consequently horizontal in position. This fact is brought constantly to the notice of the traveller by the recurrence of the flat-topped hills alluded to.

Although the South African flora is one of the richest in numbers and in the exquisite beauty of the inflorescences of individual specimens, the general appearance presented is that of barrenness and a lack of brightness in the bulk of the foliage. With a few notable exceptions, there is a general want of covering and protection or shelter for the land surface itself, as well as for the animals that graze upon it. Along the south and east coasts more particularly, where the mountains assist in attracting moisture, there is abundance of rain, and vegetation generally is luxuriant, the latter becoming more and more tropical in character as one proceeds in a northerly direction. Heavy timber exists in but small areas in Cape Colony and Natal, but in some parts of Rhodesia what is known as "heavy-bush" covers a considerable extent of country. In these northern parts the growth generally is more luxuriant, the soil being deeper, and the temperature higher, than at the same meridian of longitude to the south.

The mean annual temperature of the central and north central area of South Africa ranges between 65° and 70° F. In the north-east it is a few degrees higher, while throughout the greater part of the Orange Free State, Cape Colony, and German South-West Africa it is a few degrees lower. Rainfall does not closely follow temperature. The area to the east of the Drakens Bergen mountains is copiously watered by a fall of more than fifty inches annually. The Transvaal and Free State come within the eighteen- to thirty-inch division, and two-thirds of the area of Cape Colony receives, like a narrow belt traversing the center of the country from north to south, the rather scanty supply of between six and eighteen inches. The north west of Cape Colony and nearly the whole of the German area,

together with the western section of Bechuanaland (a portion of the great Kalahari desert), have the altogether insufficient mean annual rainfall of less than six inches. Such variations of temperature and rainfall produce sharp lines of demarcation in the conditions of different parts of the country, in the appearance of the natural herbage, and in the stock and crops which may be advantageously reared.

Large areas in the districts of light rainfall cannot be profitably cropped without the aid of irrigation, but the mountain ranges already mentioned as a prominent feature of Cape Colony readily lend themselves to interesting engineering schemes for storing rain-water against the dry season by closing the outlets of mountain gorges. To supply the requirements of live stock, surface-water is collected and preserved in shallow dams formed by the erection of low earth embankments roughly faced with rubble thrown on to form a sort of irregular pavement; but, as these stagnant pools become filthy with the droppings of animals which cannot be prevented from walking in them, and are also prolific centers for the distribution of internal worm parasites, South African farmers have been strongly urged to sink wells, in order to tap a very general and, for live-stock requirements, an excellent underground water-supply, to be found almost everywhere. Contrary to the usual experience in the Australian colonies, the water generally has to be pumped,—the most convenient power being one of the new forms of rigid, annular-sailed air-motors.

In the dry regions the rain falls very irregularly, and usually very suddenly, in deluges of thunder showers, producing for short periods muddy rivers of great depth and formidable strength in the hollows by which it escapes to a lower level. The only herbage which is capable of withstanding the long periods of drought are the so-called Karoo-bushes, with little succulent cylindrical leaves and woody stems and branches. These do not form a close sward, as grass does, to protect the surface soil particles from washing away in the flood, and the consequence is that from the dry districts South African rivers in flood are colored like pea soup. This action, continued through long terms of years, accounts to a large extent for the lower surface-level of these particular regions, and the thin covering of soil which remains, as compared with that of the more northern and eastern areas, where Karoo bush, after for some distance mixing with tufts of grass, ultimately gives place to a grassy covering, though not of the closest description, or to thorn-bush. Grass also grows luxuriantly near the coast, where rainfall is abundant; but there, as in most regions of South Africa, on the tops of mountains and north of the Karoo-bush areas, grass assumes as it matures, and as the dry season

advances, a hard form, described as "sour," on which animals do not thrive well. The herbage is not acid to the taste, but unpalatable on account of its mechanical condition.

With the exception of the regions of heavy rainfall on the east and south coasts, all parts of the country are periodically subjected to long periods of drought, which try the endurance of both live stock and the natural vegetation. The plants are found to possess various means of protection against excessively dry weather in the form of narrow, succulent leaves, which expose but a small area for the transpiration of moisture, bulbous roots, in which food is stored during seasons of plenty to be ready to sustain life and mature seed in times of prolonged drought, or, it may be, deep roots, which enable them to find a supply of moisture from the great underground reservoir. As a safeguard against vital injury from the browsing of animals, the trees, on the leaves of which small stock feed, are protected by sharp spines or thorns. The so-called "mimosa," *Acacia horrida* (Willd), is the most typical, and by far the most widely-distributed, tree in South Africa, being able to maintain its existence even in arid parts, along the courses of the channels which carry off flood waters. What its defences deprive animals of in the form of leaves, it makes good by shedding a plentiful yield of seed, which form excellent food, and are greedily picked up by all classes of herbivorous creatures.

Where irrigation-water can be had, there are few soils so deficient in lime that lucerne (alfalfa) will not grow on them to perfection, and, while yielding a large amount of green food, will continue to make the soil more fertile than before. This best of all forage crops has begun to play an important part in the development of South African agriculture.

The coast is furnished with two excellent harbors, one at Cape Town entirely under British domination, and the other at Delagoa bay, at the southern extremity of the Portuguese territory, over which Britain has acquired certain rights in virtue of a commercial treaty recently entered into with Portugal. Other inferior ports are made places of call, except when the weather is very stormy, by the ocean-going steamers to England,—*viz.*, Port Elizabeth, East London, and Durban.

Much remains to be done to develop a sufficient net-work of railways for local convenience, but the country is already well provided by trunk lines. These systems connect Cape Colony with the regions lying to the north. The western system, starting at Cape Town, and the Midland system, starting at Port Elizabeth (the two joining at De Aar), are represented further north by a single line which passes the great diamond field of Kimberley, and Mafeking, the starting-

point of Dr. Jameson's ill-starred expedition into the Transvaal, and terminates in Rhodesia. The last section of the line to reach Buluwayo, it is expected, will be open in October of this year, and not many months thereafter need elapse before Salisbury is connected with Cape Town. The eastern railway system from Cape Colony, starting at East London, extends to Aliwal North, but it also unites with the western and midland systems within the colony, and one line connects them all, by way of Bloemfontein (the capital of the Orange Free State), with Johannesburg, the gold-mining capital of South Africa, and with Pretoria, the political capital of the Transvaal.* Pretoria is also connected by rail with Delagoa bay, but the management is under Hollander influence, and is not conducted with a single eye to the development of the country. Johannesburg is also much nearer by rail to Durban than to Cape Town, but there are the disadvantages of a very steep gradient and zig-zagging of the permanent way in getting up the eastern slope of the coast range of mountains, and, moreover, passengers from Europe have to encounter eight hundred miles of sea voyage from Cape Town to Durban. The Mashona capital (Salisbury) can be reached by way of Beira and the Pungwe river, and thereafter by rail and coach. Although the journey is less than three hundred miles, the way passes through the low-lying malarial belt of country along the sea-board, in which east African fever prevails, and Beira, which is no great seaport, belongs to the Portuguese, and is still further from the main current of ocean traffic than any of the other landing-places mentioned. It is true that the railway journey from Cape Town to Rhodesia is long,—more than one thousand two hundred miles to Buluwayo, and to Salisbury about two hundred and fifty miles further,—but it lies through British possessions healthy for man and beast, and capable of such development as will guarantee the financial success of the railway enterprise.

Before railways were laid down, the carrying-trade of the country was done almost exclusively by ox-wagons drawn by spans of sixteen oxen, mostly of the Africander breed—the descendants of the original native cattle of that country crossed by imported Portuguese cattle before Great Britain assumed possession of the Cape Colony. The through traffic was done by so-called "transport-riders," who, owing to high railway rates, are in some districts not yet entirely driven off the field by railway competition. Farm work and local traffic are, in most districts, entirely dependent upon ox-power. In

* In Cape Colony in 1896 the total length of open railways was 2,253 miles—a figure which has been stationary for about four years. The traffic, meanwhile, has made most satisfactory progress. In 1893 the train-miles run were, in round numbers, nearly 7,000,000; the passengers carried, 5,335,000; the goods traffic, 863,000 tons. In 1896 the miles run almost touched 10,000,000; passengers, 8,000,000; goods traffic, 1,380,000 tons.

the arid Karoo regions small donkeys may be seen taking the place of oxen in road work, and in some parts of Cape Colony mules, and more rarely horses, work in the plough.

The terrible plague of rinderpest, the most deadly of all bovine diseases, which has been and still is making dreadful havoc among the cattle of South Africa, is a calamity the far-reaching importance of which it is difficult to realize. It is not only the meat- and milk-supply of the country that is at stake, but the bone and sinew of its working-power. The disease is a blood disorder, in which a micro-organism appears in the circulating blood. The temperature rises to 106° and 107° F. at an early stage of its development. Every organ of the body becomes deranged, and the animal usually dies in about a week, after a period of extreme suffering and prostration. On its first appearance in a country its ravages are most deadly. Only one per cent. of the animals attacked in South Africa have recovered. The disease entered the country from the north, having found its way probably from Egypt, where in 1881, we believe, a cattle murrain devastated the herds, and bred, through the pollution of the water-supply, a deadly plague among the people. Joseph Thomson, the African traveller, describes it, though imperfectly, in his book on Masailand, and other explorers and hunters have mentioned its ravages upon buffaloes, wild pigs, and the numerous species of antelope.

It is a well-known fact that cattle, such as bullocks of the Africander breed, are superior to horses and mules for the heaviest part of the traction work under South African conditions. They are able to exist on scanty and inferior fare, and to withstand the effects of rough roads and the great heat of the sun by day alternating with low ranges of temperature at night, with which the equine species could not successfully cope. Another serious drawback to the substitution of mules and horses for oxen is the liability, particularly in the low-lying districts of the country, to periodical outbreaks of horse sickness, causing the sudden death of thousands of valuable animals. Horse-sickness is a febrile disease produced by the growth of a micro-organism in the blood, and is probably contracted during the inhalation of fogs which rise from the surface of the ground at night, as animals housed and properly protected do not suffer from it. After the death of so many bullocks, many mules will be required in South Africa, and America will no doubt be called upon to contribute a large proportion of this supply.

It is impossible to foretell the far-reaching influences for good and evil which the loss of cattle by rinderpest will have upon the future of South Africa. It will certainly ruin many struggling agriculturists, and produce great privations and suffering among the

Kaffir population. It has been credited with driving the Matabele and Bechuanas into rebellion. It will lead to the extension of crop cultivation among natives who formerly depended largely upon meat and milk for their subsistence. During the recent unsettled times, in which native labor was liable to be driven away from the great mining centers, it has led to the maintenance of a supply of labor which, but for the hardships due to the rinderpest, would not have been forthcoming. This has led to reduction of wages at the mines, which, contrary to the general economic principle, has been a boon to the community at large. It has transferred a number of doubtful mining ventures that maintained a precarious existence between success and failure into the class of paying properties. It has relieved to some extent the pressure of high wages upon the agricultural industry,—a condition which was induced by the excessive wages paid at the large mining centers. It has been the practice for young men from the native population to repair to the Kimberley, Johannesburg, and other mines, where they have earned in a few years as much money as was necessary for each to purchase two or three wives and as many cattle as would enable them to live in ease and idleness for the remainder of their natural existence. The reduced wages will necessitate a longer period of work before this tawny lord of creation will be in a position to settle down to a life of indolence and grow fat upon the produce of his wives' labor and of his milch cows. The extension of the period of work will be wholesome to himself and a benefit to the country, and it may also prove a retarding influence to the too rapid increase of population. The most recent phase of the labor question, owing to the prolonged state of general unrest and distrust, is the scarcity of Kaffir labor at the Johannesburg mines. A greater feeling of security, and not the raising of wages, is the necessary remedy in this case. In the Kimberley Compounds, where it is necessary to prevent direct communication between the mine workers and the people who are at liberty, with the object of stopping the wholesale stealing of diamonds, the life of the native workman is of the most pleasant and agreeable kind, as may be seen from the healthy and happy appearance which all and sundry present. The period of work is not too long, and the ample hours of leisure are spent in basking in the sun, gossiping, and other relaxations.

The great mass of the population of South Africa belongs to the Bantu race of dark-skinned negroids, divided into many distinct tribal groups, which, until British influences intervened, carried on incessant wars with one another. Prominent among these may be mentioned the Zulus, Makalakas, Basutos, Pondos, Bechuanas, Damaras, Mashonas, and Matabeles. It is physically a well-developed race, and its

mental capabilities are superior to those of the negro in the tropical regions lying to the north. The prominent representatives have been described as "fine, powerful, able-bodied men, reserved and self-possessed in manners, but courteous and polite." It cannot be denied, on the other hand, that many of the most prominent chiefs have been monsters of cruelty, and have ruled their people with a rod of iron, or that savage excesses of the most wicked kind were often exercised on the unfortunate white victims who fell into the hands of the rebels in the late Matabele war. Contact with the white man, though it has not been uniformly advantageous to the race, as will subsequently transpire, has developed a better and more Christian spirit in this respect. It appears, on the good authority of the British resident in Basutoland,—perhaps the most advanced and prosperous of all the native communities under British control,—that the more enlightened of the people were genuinely horrified at these cruelties.

One of the most conspicuous advantages which Great Britain has gained in successfully "picking the eyes" of the African continent by selecting the richest and most healthy areas for the development of an energetic population is the immense reserve added to her fighting power. She has become the mistress of a race of warriors, capable of rivalling the world-wide fame of the hill tribes of Northern India in their love of warlike adventure and their skill in modern warfare.

In Cape Colony there were, at the last census, taken in 1891, more than fifty thousand Hottentots,—a race much inferior in intellect and physique to the Bantus; and a few specimens yet remain in the semi-desert regions of a still lower and probably earlier race,—the Bushmen,—who are supposed to have left their marks in the shape of unique drawings of animals on the polished surfaces of basaltic rocks and in caves in different parts of the country. Neither of these races, or yet the fourteen thousand Malays who have settled in Cape Colony, call for much consideration in discussing the future prospects of South Africa in regard to population.

The future of the Bantu family is in itself a large enough question for serious consideration. Under native rule the warlike proclivities of the men, whose main object in life was bloodshed, while the women, who were little better than slaves, did the manual labor of the community, restricted the tendency to the inconvenient increase of population; but, with the cessation of wars under the benign influence of civilized government, the population has started on an era of expansion which will probably keep pace with the development of the agricultural resources of the country, if it does not over-reach it.

The wants of the native in his natural state are not numerous. Of the grain crops the "mealie" or maize is the most widely grown and

most important. The next most important grain crop is Kaffir-corn, or great millet, *Sorghum vulgare*, the juár of India. This, like maize, is a dry-land crop, but it can be also cultivated under irrigation. Wheat grows well in some parts, but in coast districts it becomes increasingly liable to suffer from rust or mildew. The high rate of labor and other local difficulties will prevent South Africa, for a long time at all events, from becoming a grain-exporting country. There is great scope for the expansion of grain-growing, but, with an ever-increasing population,—white and black,— it is more likely to be a grain-importing and -consuming, than a grain-exporting, country.

In spite of the unsettled state of things in Johannesburg and the native rebellion in Rhodesia, South Africa was in 1896 the most popular center for emigration. People flocked to it from Australia, Europe, and America, in a way that cannot well be explained.

But conditions are not ripe for the reception of many of the classes which go to form old communities. People who merely drive the pen and are not fit for manual work are not wanted at present. Mining enterprises must take the lead in the development of the country, and consequently engineers, surveyors, and mining managers of skill and ability will be required to occupy positions of trust. Men wanting in individuality, and whose qualifications are only second-rate, would do well to remain at home. They are more easily recognized and even less in demand in a new than in an old country. No energetic settler who is an expert in a handicraft, and who is willing to make a living at any kind of employment that presents itself, until he becomes familiar with his surroundings, need despair of ultimate success in his own sphere of work.

One of the curses of the longer-settled parts of South Africa has been the belief that a white man ought to be superior to manual labor in a black man's country, but these ideas do not follow in the train of success in pioneer enterprises, and they have produced in Cape Colony a class of people known as "poor whites," who live a wretched existence, morally and physically, and are rapidly becoming a serious burden and anxiety to the State.

Energetic agriculturists and experts in gardening and fruit-growing, with a few thousand dollars of capital, will find full scope for their abilities, and excellent markets at the large mining centers.

South Africa will one day be a great empire; but, although the skeleton has been outlined, it will take considerable time before the flesh can be built up. Progress will have many difficulties to contend with, climatic,—alike affecting crops and live stock,—racial, and political. The blacks will not be difficult to govern when they fully realize the justice and the firmness of British authority. It

will never do to treat natives too leniently when correction is necessary. They have been so accustomed for generations to the severity of their chiefs that they even seem to like it! Leniency to a black man is invariably mistaken for weakness, and advantage is taken accordingly. One serious feature in the future of the South African native is hidden in mystery, which only time can dispel,—*viz.*, the result of the influences of the evils which usually accompany European civilization when it is first meted out to inferior races. For example, the curse of strong spirituous liquors, to which natives too easily fall victims, and the introduction of syphilis, which has played such havoc among the native population in India, and has got so thoroughly rooted in Africa, that in a well-governed State like Basutoland, of which reliable statistics are available, it appears at the top of the list as the most prevalent of all the diseases under medical treatment. These are deplorable circumstances, as they undermine at one and the same time the physical and moral well-being of the communities affected.

Although much has been heard of the disagreements between Boers and Britons, little fear need be had of permanent or serious difficulties arising between them. The Boers form one of the most excellent sections of her majesty's subjects,—solid, sober, substantial, frugal, and sagacious, though some may be dogged and obstinate in their isolation and from want of education in the world and its way.

In bigotry and narrow-mindedness, and in other well marked characteristics, many of the less progressive of the class strongly resemble the old Scottish Presbyterians of a hundred years ago, and, being of the same race, there is no reason why time and education should not do for the South African Boer community what they have done for Scotchmen. The root of the difficulty does not lie so much between the Boers and British as in the the introduction between them of an alien Hollander-Dutch element as educated and accomplished mischief-makers, and the acknowledged corruption of the government, due largely to their and the German Jew ascendency which prevails in the secret council of the so-called republic of the Transvaal. It may be accepted with confidence that Britain means to retain, despite all opposition, the paramount power in South Africa, and to this end she has already strengthened the permanent garrison of Cape Colony. It is not believed that a Boer war is likely to occur, and such an event would be deplored by all who have a personal knowledge of the Boers and their ways; but, if such a calamity were forced upon us, we believe there would be little bloodshed, because so overwhelming a British force would be sent as would make the result a foregone conclusion. The hopeless natufe of the fight would be-

come apparent to the most ignorant of them, before they had to pay a penalty similar to that from which Greece is now suffering for her stubborn indifference to the counsels of wisdom.

It is impossible to closely estimate the shrinkage of capital and the injury done to trade and to the development of the country by the extremely unsatisfactory political situation in the Transvaal. But, while admitting the monetary loss to individuals to be very great, amounting to tens of millions of pounds sterling, it is encouraging to see, from the official returns of the out-put of gold during 1896 at the Whitwatersrand (the Johannesburg gold field), that it was a few ounces more than the out-put for the previous year. In 1896 it amounted to 2,281,544 ounces, and in 1895 to 2,277,635 ounces, which figures, at the common estimate of £4 per ounce, give the handsome sum of more than £9,000,000 sterling in each of the two last years. Another hopeful feature is the increase in the import trade, as is shown in a return recently made by the French consul at Pretoria, who states that "in 1896 imports into the Transvaal amounted to 352,000,000 francs,—an increase of 107,000,000 on those of the previous year."

The struggle which European powers are making to secure a greater foothold in Africa is due in a great measure to the desire to secure the new market for home manufactures which will open up as the country becomes civilized and more densely populated.

In connection with Professor Wallace's careful and intelligent review, the following, from a trusted correspondent of the London Daily *Chronicle*, published May 28 last, will be read with interest.—EDITOR.

I have within the last few days seen many of the leading authorities on the Rand, and I found that, while for once they were absolutely unanimous about the reforms that are required to place the gold industry in a healthy state, there exists the widest possible diversity of opinion as to the amount of relief to be expected from the government. A very small class of Anglo-Boer tell you that things are sure to come right, and that the rules of this rustic republic must save the Rand in order to save themselves. I must confess that, with the exception of one or two well-known personages, you require the lamp of Diogenes to discover these hopefuls. The great majority of the Rand leaders have lost faith in Rand promises. In one respect there is entire unity of opinion,—that, whatever the Transvaal government does, it will be guided by its own pecuniary interest, and not by a desire to benefit the mines or the miners.

The representatives of English, German, French, and American syndicates and companies tell you that they would have no anxiety, if it were merely a struggle between the revenue of the State and the profits of the mines, because it might ultimately dawn on the dullest government that in the long run a liberal policy would pay best. But in the present case there comes between the government and the public a knot of Dutch and German speculators, who are making enormous fortunes from

monopolies that squeeze the life out of the gold industry, and linked with these are members of the executive and some of their relatives and friends. One member of the government is known to be realizing a princely revenue out of the dynamite contract; and you can understand how eloquently he is likely to plead for its abolition! Evidence has been laid before the commission of inquiry that dynamite with free trade can be sold for half what it costs to-day; that the industry is paying over £400,000 a year for its explosives, more than a fair price; and that of this sum the government gets only £50,000, while seven times as much goes to enrich the lucky German manufacturers, Dutch contractors, certain "unknown persons in Pretoria" (who are really well known), to whom 22,500 shares were allotted, and Mr. Lippert, who got 25,000 shares. The reader will readily conceive how these individuals will combine to press on President Kruger the equity of cutting down their profits by seventy five to one hundred per cent. A representative mining director said to me: "The dynamite monopoly is not the most crushing of our grievances; but it is the most iniquitous—it means nothing but plunder"; while the manager of a large group of mines, himself rather friendly to the Boer government, declared that at least one-third of the present charge for explosives must come off. This gentleman remarked that there had been some improvement of late, for in several recent instances the administration had declined to grant monopolies. A few years ago every concession was of this character, and there could be no doubt that officials were bribed to secure these privileges. This state of things is a bar to reform. A partner in one of the largest concerns in Johannesburg remarked: "We are asking the government to annul the dynamite contract, and to expropriate the Netherlands Railway. But the contractors and railway directors will fight for their rights. They are hand in hand with State officials, and who knows what exposures they may threaten if they are cornered? I will believe in these sweeping reforms when I see them; and paltry reductions will do us no good."

Of all the burdens on the Rand the railway charges are the most oppressive. The lines belong to the Netherlands South African Railway Company, which is always indicated in print as the Z. A. S. M., these being the initials of the Zuid Afrikaansche Spoorweg Maatschappij. This precious organization has made a world's record with some of its rates. It charges from Vereeniging (the first station in the Transvaal) 7.7d. per ton per mile for heavy goods—coal, machinery, timber, etc —the Cape government and Free State railway rates being 1 1-3d. for the same goods, the Natal rate nearly 2d., and the Portuguese (from Delagoa bay) 2½d. A merchant sent an air-compressor from East London to Johannesburg, and was charged over the Cape lines 9s 4½d per mile, over the Netherlands section £1 16s 5½d per mile—nearly four times as much. The machine cost in England £1,269, and, when it reached Johannesburg, £2,018 17s. Bringing it over had increased the price over fifty per cent But this is moderation itself compared with some of the freaks of the Z. A. S. M. Some rails were bought in England for £97 5s 8d,—delivered free on board,—whereas the railway charges alone came to £158 1s 2d, and, when these rails reached the Rand, they had cost £296 8s 2d,—an increase of 204¾ per cent A quantity of retort carbon, imported from home, was delivered free on board for £20, and, when it arrived at Johannesburg, its price had run up to £132 6s 4d, or 561½ per cent. on the original value. A wag remarked that, in the deplorable event of a war between the Transvaal and Great Britain, if the republic should organize the officials of the Netherlands Railway into a cavalry corps, there would be poor chance for the Britisher, because nothing could withstand their charges. It is perfectly certain that the gold-mining industry cannot stand them. Almost everything the mining engineer uses, or the working miner eats, drinks, or wears, is made at least fifty to one hundred per cent. dearer by the railway monopoly alone. As a pretty illustration, by no means an extravagant one, take the following actual instance of the working of these transit

charges, in the case of timber,—an article of prime necessity in mining. It must be studied in detail in order to realize the full beauty of the transaction. A cargo of prime quality pitch-pine was sent by sailing ship from America to Johannesburg, *via* Delagoa bay, and this is how they did it:

Cost in the States	£2,379	7	1
Insurance and commission	242	19	9
General average bond	105	9	2
Port dues	66	16	8
Freight to Delagoa bay	3,012	10	0
Landing, forwarding, etc	1,503	15	0
Duty, etc	90	3	0
Cost at Delagoa bay	£7,401	5	8

From Delagoa bay to the Rand is 396 miles, and the carriage of the timber for this paltry distance just doubled the cost of it. Thus:

From Delagoa bay to Transvaal frontier, 58 miles	£ 844	2	6
Frontier to Johannesburg, 338 miles	6,517	6	0
Transvaal duty	42	16	0
Exchange and interest	52	9	0
Total	£ 7,456	13	6
Add cost at Delagoa bay	7,401	5	8
Total at Johannesburg	£14,857	19	2

I have before me a series of actual accounts showing that the original outlay for Oregon pine, Baltic deals, sheet lead, galvanized iron, steel plates, cement, tubes, lard oil, candles, bolts, nails, and mining machinery had been increased by carriage to the Rand from 53 to 792 per cent., and of this prodigious excess of cost the railway charges were responsible for a proportion ranging from 20 to 50 per cent. It costs, in every instance, about twice as much to bring goods by rail four hundred miles as to carry them by sea six or seven thousand miles. But why complain? The Netherlands Company, with a capital of £1,166,000, make a profit every year of £1,330,000, of which the government is entitled to about £700,000, leaving a comfortable return for the shareholder such as in these days few railways earn. Verily since the days of Canning "the fault of the Dutch" has not been taking too little and giving too much. In this case there is an obvious remedy. The government of the republic is entitled to buy out the Z. A. S. M., and by doing so at once it would soon be a large gainer. A reduction of rates would bring about an enormous increase of traffic, which would, without any question, produce an equal return to that now raised, while bettering the revenue of the State in every other direction.

This matter of railway rates, as affecting the cost of living and the chances of obtaining employment, is a serious one for workingmen who may be tempted by the high wages prevailing on the Rand. There are men here who are making £1 a day as miners, while a smaller number earn from 12s to 15s; but expenses are so high that married men with a wife and two or three children will find it hard to live in comfort A statement submitted to the commissioner by a working miner showed that it costs four times as much, on an average, to live at Johannesburg as it does in England—the one being the cheapest and the other the dearest place in the civilized world. Speaking generally, milk is six times, butter three times, meat and bread double, groceries seven times, and rent six or seven times what they are at home. Single men can save money, but they must reckon the cost out and home again, which

cannot easily be less than £50, allowing for loss of time, and may be more. A working witness said that, if he had foreseen all this, he would not have got married and had five children to support. "Well," said the commissioner, "we all make these mistakes." My advice to the married miner in England is to hesitate about bringing his family to the Transvaal until these monopolies and railway rates have been reformed. It is a pitiless land for the unemployed, as I have seen in several cases; and it is to be remembered that there is practically only one industry. Of course the chances of employment would be enormously increased, if the economic conditions were ameliorated. In fact, there will be a brilliant future for gold and coal mining in the Transvaal, when honesty and a little common sense have taken possession of its rulers. Mr. Laurie Hamilton, speaking for the Barnato group of mines, states that they have six companies running with 400 stamps, seven idle with 650 stamps; but with better economic conditions they could easily have, within twelve months, 1,840 stamps at work, and a further addition later of 1,350 stamps. By the year 1900 this single group of mines might fairly expect to have 3,190 stamps running, and by the same time the various other groups, several of which are now closing down, reducing wages, and dismissing hands, could, and probably would, have 9,000 stamps at work. The economies which the United Rand are now pressing on the government would reduce the cost of working by 6s per ton, and restore dividends on millions of money, at present sunk uselessly. Will these economies be made? The only chance seems to be that the imminent, and, it is to be hoped, large loss of revenue will teach the Boer rulers wisdom. Only one must never forget Oxenstiern's lesson to his son: "You have no idea with how little wisdom the world is governed;" and the Swedish chancellor had not heard of the Transvaal.

DIFFICULTIES OF TRANSPORTATION IN THE TROPICS.

By C. P. Yeatman.

YEAR by year the manufacturing ability of the great industrial nations is outgrowing the demand which exists within their own territory; in the United States, as in England and Germany, the manufacturer is looking abroad for a market for what he cannot sell at home. Each decade finds the capitalist more at a loss as to how to get a good interest on his money.

To both of these the subject of methods of transportation in use in South American countries is of interest. To the manufacturer, because the weight and size of his packages, and the manner of packing, must conform to usage, or he cannot hold the trade; to the capitalist, because the fact that freight pays, apparently, a very high tariff in the tropics gives hope of a better return for his investments than he can expect at home.

Let us take, for example, the condition of tariff existing in Colombia, the nearest South American neighbor to the United States. The lines of traffic resemble the arteries of the human system, as they begin at the few sea-ports of the country and rapidly branch out in diverging lines for the interior. Just as the small arteries divide among themselves the total amount of blood carried by the principal artery, so the different roads leading from the sea-ports to the interior divide and sub-divide the traffic, until what at first was only a small amount becomes infinitesimal in quantity.

Leaving out of the discussion the Panama Railroad, as it has nothing to do with the interior of the country, the leading entry port is the city of Barranquilla, with a yearly import of thirty-four thousand tons, and exports of twenty-three thousand,—a total of fifty-seven thousand tons per annum. As the navigation of the mouth of the Magdalena river, on which Barranquilla is situated, is not practicable, nearly all the traffic is carried to and from the sea-coast by a three-foot-six-inch-gage railway, eighteen miles long, having nothing remarkable about it except its ocean pier, which is of steel and four thousand feet long, with twenty-six feet of water at its head, being surpassed in length by only two piers in the world. From Barranquilla the traffic goes up the Magdalena river on steamers carrying from one hundred and fifty to three hundred tons each. So far the transportation of packages of ordinary size and weight offers no diffi-

culty, but, when the freight leaves the river, trouble and expense begin ; for there are but three short railroads leaving the eight hundred miles of navigable river, and nearly every package which enters the interior of the country must, in some part of its journey, go on mule-back, if it is small enough, or find some special mode of conveyance, if too bulky for a mule, or of more than one hundred and twenty-five pounds' weight. Let a single package pass the mule limit, and the cost of its mule-road travel will go up with a startling bound.

There are professional pack-carriers on some roads, who make a specialty of carrying burdens which the sturdy and much enduring mule cannot stagger under. On some of the roads you will see at times what appears to be a live box, staggering slowly and painfully down the mountain-side ahead of you ; as you draw nearer, you may hear the box grunt, very much as an old pack-mule does at each downward step on a steep road. There is something uncanny about the whole proceeding, if it is your first experience, and you happen suddenly to overtake the box, going down hill, for the moving, swaying, and grunting mass has no visible means of support, and no apparent excuse for behaving in such a manner. Perhaps you may read on its back, "Mason and Hamlin Organ Company," or some similar legend, but that is no help in solving the perambulating mystery, for whoever heard of a boxed up organ wandering alone down a steep mountain path, and grunting as it reeled along? Very likely the road is too narrow for your mule to pass your fellow-traveller ; so you are obliged to follow in its wake. But at last you are able to pass ahead, and you find that the organ is in no way to blame for moving, for it has a man under it. Short and stumpy he may be, but the muscle on him reminds you of the pictures of old Atlas holding the world on his brawny shoulders. In one hand he carries a long, stout cane, with which he steadies himself on the slippery clay, and, when he wishes to rest, he backs up to the bank on the side of the road, settles the lower end of his load against the higher ground, and props up the upper end with his stick ; then he is free to slip the plaited maguey fibre bands off his shoulders and forehead, and step out from under his burden.

Up the next hill perhaps you will overtake a woman pack-carrier, her skirts tucked up to her knees, and below the skirts, in prominent view, great knots and masses of corded muscle, which form her not graceful, but very useful, underpinning. Ask her how much weight she carries, and you may get the answer, as if it were a child's load, "ocho arrobas, no más,"—equivalent to, "only two hundred and twenty pounds." As you catch sight of her wrinkled face, you may thoughtlessly remark that it is a heavy load for one of her years ; her

MAGDALENA RIVER STEAMERS.

answer is apt to be: "You should see my grandmother; she does carry heavy loads; I am not full-grown yet." This is said with so injured an air that you ride on wondering why you had not remembered that a woman has a right to be touchy about her age, even if she is not dressed in the height of fashion. As to the grandmother, and the probability of her still being able to carry burdens in this

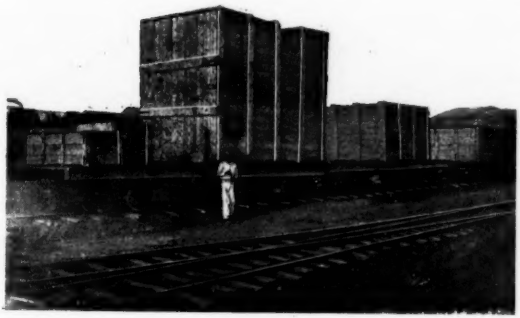
AN OCEAN STEAMER LYING OFF BARRANQUILLA.

THE PUERTO COLOMBIA PIER, 4000 FEET LONG.

world, you are apt to be strongly of the opinion that the pack-mulish old lady has drawn entirely on her imagination; but do not be too sure of that, for the glaring tropical sun brings wrinkles quickly, and, where women are frequently mothers at fourteen years of age, a great-grandmother may still be a very active member of society.

Is this sort of freight-carrying expensive? Rather! A twelve-arroba, 330-pound package, which is generally the maximum for men, as a nine arrobas is for women, may cost $1.50 for one hundred miles, or $10.18 paper per ton per mile.

THE HEAD OF THE STEEL PIER AT PUERTO COLOMBIA (SABANILLA HARBOR).



THE LARGEST PACKAGE HANDLED BY THE BARRANQUILLA RAILWAY.
(Box measured 1934 cu. ft. and weighed about 8 tons.)

Lighter packages, which a mule can carry, pay from $0.65 to $3 paper per ton-mile, according to the condition of the road, health of mules, etc.; but, when the weight of a single package reaches a ton, it is better not to ship it, for the method of transportation in that case is to place the load on pieces of wood, like sled-runners, and haul it by a rope attached to a windlass, or capstan, fixed in the road a short distance ahead.

As the roads are narrow, crooked, steep, slippery, and often near the edge of a precipice, it is easy to imagine that this sort of traffic is tedious and costly. In fact, the government is perhaps the only party rich enough to indulge in it. There are records of pieces of mint machinery being five years on their way to an interior city, one hundred miles from the Magdalena river, and in that time they had been dragged but half the distance at a cost of nearly $15,000. This variety of rope haulage costs about $30 per ton-mile.

THE ENGLISH HOTEL AT BARRANQUILLA.

MULE DRIVER AND WOOD SELLER.

In carrying rails from the Magdalena river to Bogotá, for a small railway to be built there, it was at first attempted to allot two short rails to each mule, letting the ends of the rails drag on the ground behind the mule. This plan was soon abandoned, because the ends of the rails wore off badly on the ground, before they reached their destination. Then a tandem team of two mules was fitted out with a twenty-foot rail, weighing thirty-five pounds per yard, on each side of them. They soon learned to keep step beautifully, as it behooved them to do. A contractor was recently obliged to finish a piece of railroad by a certain date, and found that he lacked twelve thirty-foot rails. He had no time to import them, but managed to buy the required number from a neighboring railroad, less than ninety miles away; as the roads were not of the best, he was obliged to pay $1,500 for the transportation of those twelve rails.

Let us trace the cost of carrying a sack of coffee, which weighs about one-sixteenth of a ton, from the plantation on which it is grown to the seaboard. As the best coffee grows at not less than three thousand feet above sea-level, it must go an average of about eighty miles on mule-back before reaching the river; this means $8.50 paper for the mule. Supposing it to travel five hundred miles on the river, that freight will be $1.92 to Barranquilla; then eighteen miles of railway travel costs $0.33; total, $10.75 in Colombian paper, or, at the usual exchange of 150 per cent. premium, the total cost of 598 miles' travel of our sack of coffee is $4.30 in gold, making an average freight per ton-mile of $.01146 gold. From the coast to New York the freight is $0.40 for the sack, or $0.0032 per ton-mile.

We have here the startling fact that to carry a sack of coffee 2,518

WATER TRANSPORTATION IN COLOMBIA.

miles by river, railroad, and ocean steamer costs but 38 per cent. of what it does to carry the same sack eighty miles on a mule Yet in this we see another instance of the proneness of human nature to strain at a gnat, while the camel goes down as a matter of course. The river steamer, the little railway, and the ocean freighter are looked on by the average Colombian as extortioners which, by their high rates, are robbing him of his hardly-earned profit; but the sturdy little mule is his tried and true friend, and he is begrudged nothing.

In passing over almost any mountain mule-road, if you are a stranger to the path, your baggage-mule-driver is apt to enliven the way with anecdotes of experiences of other travellers who have passed that way.

Here on this narrow slippery ledge Don Pacho ....'s baggage-mule struck his up-hill trunk against the corner of that rock, and over he went into the gorge below. Don Pacho was just returning from Europe, and his trunks were too large for this road. In the crotch of that tree one trunk was found; in that thicket, far below, are still some pieces of the other trunk; and all the way down that dizzy slope the contents of the trunk had been scattered; while in the bottom of the ravine the mule was found quietly nibbling leaves, as if he had gone through the whole per-

THE WOOD MERCHANT.

formance just to get at them. In passing close to a muddy stream, you are warned to keep up on the steep bank, at the risk of a fall, for in that miry ooze below you rests a pack-mule with his two sacks of coffee still on his back. For a day or two after his fall his ears could still be seen sticking out of the mud, but a freshet of a stream had covered him up, and probably sunk him deeper. "How did he get there?" "Oh, the most natural! Two pack trains meet themselves here on this slippery bank, with the black mud without bottom below. All try to go themselves up above the others, one falls himself against the other, and that one rolls himself over, and finds himself in the mud, with the head for the water. He raises himself, and falls himself forward, twice or three times, and—adios, mula! The mire swallows him."

Who can blame the Colombian for sympathizing with the mule? But let the traveller go on a river steamer, and listen to the deck hands tell the history of each bend and rapid. Here the mud-drum of the Elbers burst, killing four men; here the Montoya, the pride of the river, was sunk by a collision; there the Bolivar, the largest of them all, was run upon a hidden sand-bar, to save her freight and passengers, when she was found to be fast sinking from having struck a sunken snag. There the Medellin's boiler blew up, and the death-rate ran high; this is the "Friar's Bend" of the river, because here a steamer blew up, as she was going up the swift current, and on that cliff was found the body of a friar, one of the pas sengers.

POTTERY GOING TO MARKET.

The mule road has not a monopoly of disasters. Has the railway nothing to tell? Yes, as much as any mule road, and, besides, it is ridden by an "old man of the sea" in the shape of legislation difficult to get rid of;

COLOMBIA FREIGHT-CARRIERS.

yet there is a general complaint through the country against the high railroad freights. Let us examine those of the Barranquilla railway.

The average freight charge per ton during the past year was $6.67 paper, or $2.67 gold, making fifteen and a quarter cents per ton-mile, which, compared to the average on United States railroads,—$0 0084,—seems excessively high; but there are various reasons for this. In the first place the railway supplies the labor which handles all import cargo in the custom house, weighs it, moves it for inspection, and delivers it to the consignees; for this service, it is allowed to increase its maximum tariff eighteen per cent.

The government receives about three per cent. of the gross freight earnings, besides a State tax amounting to about the same per cent. of expenses as that constituted by the railway tax in the United States. Deduct the first two items, and the average freight-rate amounts to $2.1825 per ton, or 12 cents per ton-mile, which is still fourteen times the average charge in the United States. But the average haul of the freight in the United States is 122 miles, while on the Barranquilla railway it is 17½, making this road's proportion of loading expense seven times as great as that of the United States railways.

The tons of freight hauled one mile, divided by the total number of miles of railroad, gives, for the United States, 473,500, and, for the Barranquilla railway, 56,700. That is, the average railroad in the United States does eight and a third times as much freight work as the heaviest traffic-carrying road in Colombia.

Comparing the passenger traffic in the same way, the average United States road carries twenty-nine times more. Eleven per cent. of Colombian passengers are government officials, who go free to the

number of twenty in one day, and forty-five per cent. of the paying passengers pay but twenty cents paper for a round trip of thirty-four miles, with sixty-six pounds of provisions. This is equal to $0.00235 gold per mile,—but little more than one-tenth of the average United States charge.

Colombian receipts from passengers and baggage are 4.6 per cent. of the total receipts, while those of the United States average 29.16 per cent. The highest through passenger-rate in Colombia is equivalent to $0.0925 gold per mile, or four and a half times the United States rate. Colombian operating expenses, reduced to gold, are considerably in excess of those of the average United States road, as might be supposed from the shortness of the road. Are these rates exceptionally high even for the tropics? No. One road of thirty-two miles in length charges four times as much per ton per mile as the Barranquilla charges, and another, thirty-four miles long, charges five times that rate.

COLOMBIAN TRAMPS.

The great drawback to railroads in Colombia is that they must receive paper for their services, and pay their debts in gold. There is also the constant possibility of a revolution which may at least stop traffic, small even in time of peace.

Has this road no opposition? Yes, a road sixty-five miles long was built from Cartagena to the Magdalena river, but it is not a financial success. For many years there have been schemes on foot to open the mouth of the Magdalena river to navigation by ocean steamers, so as to bring the cargo directly to Barranquilla; but to the average engineer the enthusiasm with which those who have had no experience with such work advocate its immediate execution is really funny.

It is a well-known fact that, where a jetty or dike is built to narrow a stream, in order to deepen its channel, a new bar will form below the jetty, unless there happens to be a narrow channel there already, very deep water, or a strong cross current, capable of carrying away the river sediment.

The west bank of the Magdalena has been prolonged out to sea by a deposit of sand which it continually brings in its muddy current, making a sweeping curve of narrow sand-bar five miles long. The sand is deposited on the west side of the current only, because the almost constant trade winds, or gales, blowing from the north-east, force the current to that side. As the sand spit grew, the wind bent it to the south-west, so that, at its end, it is nearly parallel to the direction of the wind. Probably, when the river has built a considerable strip parallel to the trade wind, it will be satisfied, and will spread its mud more evenly on the ocean's bottom.

Fifty years ago there was a belt of land on the east side of the river, extending to within a mile of the present terminus of that on the west side; that is, the river ran four miles into the Caribbean sea, enclosed on each side by a natural dike of land. At that time, as well as now, there was a comparatively shallow bar at the mouth of the river where it met the sea. As the land on the east side of the river was gradually washed away by the heavy surf of the north-east gales, which last with more or less force during six months of the year, the mouth receded, and the bar with it, until it reached its present position. Is it not reasonable to suppose that jetties would have to be extended farther even than the natural dikes, which the river itself undoubtedly built in its leisure time, in order to have a permanently deep outlet into the sea?

Even if we imagine the construction of a series of jetties four miles long in rough sea, it takes a wilder freak of imagination to think of maintaining such work against the heavy surf so common there. That a channel for twenty-four-foot-draft steamers could be made and maintained for any less than the cost of the Mississippi river channel does not seem possible, and it would probably cost much more; but, at the rate of cost of that work, the maintenance, and six per cent. interest on the capital, would amount to more than double the total receipts of the railway.

When a steamer of light draft manages to go up the river, she cannot reach Barranquilla, because a low, swampy island keeps her two miles from the town; there being no wharf, pier, or road, she must use barges to unload. This causes so much delay that a pier and short railroad are a necessity. To make this permanent would be expensive, as the river bank is low and easily washed. The result of this

expense would be only the exchange of a railroad eighteen miles in length for another two miles in length, and to the average mind the advantage, considering the expense and traffic, is not apparent.

And yet we have much literature on the subject. One of the United States consuls, not long since, was so convinced that the Barranquilla Railway was the great retarder of the progress of the country that he reported very enthusiastically in favor of opening the mouth of the river at once. It was the "burning question." "In five or six years, at the farthest, the present facilities will be entirely inadequate for the commerce of the country; even at the present moment, there is no accommodation for the export of timber, log wood, ivory nut, railway sleepers, and cattle (as they cannot resist the extra cost of the railway freight), or for the exportation of heavy pieces of machinery, etc." As the gentleman had been transplanted from the west less than two years, he had not yet outgrown the boom fever. When I first went to Colombia, nearly nineteen years ago, I met several foreigners who were afflicted with this disease; most of them are under the ground, some have left the country; but all who remain have long since had that kind of fever thoroughly eradicated from their systems. In fact, for a complete cure of any form of boom complaint I can conscientiously recommend a residence in this climate. The following table of value of exports from Sabanilla, including gold and silver, gives the highest and lowest points which the traffic reached between 1874 and 1894:

1874	$ 8,764,786.
1875	9,082,040.
1877	6,800,145.
1881	12,399,609.
1885	3,807,851.
1891	14,409,290.
1894	10,781,075.

The fluctuations are caused partly by revolutions, which nearly paralyze traffic for a time. As the export traffic has really increased less than twenty-five per cent. in twenty years, and the railway has rolling stock sufficient to carry three times the present traffic, I think it may hope to still be able to cope with what may come for a few years more.

As for the freight-rate being too high for lumber, the present price of rough sawed lumber at the mill in Colombia is $150 paper per 1,000 feet, board measure, or $60 gold, while the freight-rate is $6.40 paper per 1,000 feet. The cost of the lumber is high, before the railway receives it, as Georgia yellow pine shipped *via* New York costs but $91.40, paper, independent of import duty. Still 168 tons were

shipped last year. Of log wood 329 tons were carried. The invention of celluloid discouraged the ivory-nut trade, but in 1895 that freight was 621 tons. The general price of fat cattle in Colombia is equivalent to $0.048 gold per pound on foot, or about 9½ cents per pound of useful meat, while the export price of salted United States beef is $0.056 per pound. What inducement is there to export live cattle from Colombia, even if the railroad should transport them free? Railway sleepers at $1.50 gold—the price of the export tie delivered in Colombia—would have great difficulty in finding a purchaser anywhere, except at the Isthmus of Panama, where the demand is limited.

As for our inability to transport heavy pieces of machinery, etc., the heaviest single package of which there is record weighed 9 tons, the longest package measured 45 feet, and the largest 1,934 cubic feet. Nothing presented for transportation has ever been refused by the railway, so it cannot be blamed for not having carried larger or heavier parcels. In its yard in Barranquilla are pieces of costly machinery which have been waiting for years for the owners to claim them, but mules large enough to carry them have not yet been found. Any person who has seen the system of transportation in the interior would consider the statement that any railroad could not carry large enough packages for the needs of the traffic a huge joke; yet such has been the United States consular system that men come and go without seeing enough of the country to have an idea of its needs, and expect to find a New York Central Railroad built for a traffic which would require on that road but one round-trip of a freight train in twelve days, and one passenger train making a round trip every ten days. It is to be hoped that, with the civil service improvement, consuls may have an opportunity to stay in foreign countries long enough to accumulate useful information.

The hindrance to traffic in Colombia is not the railroad or steamboat, but the obstreperous, long-eared mule. At present, a ton of freight for the capital may be brought from Europe, 5,500 miles, and carried up the river, 600 miles, for $24; but his royal highness, the mule, must have $64 gold for carrying the same freight ninety miles, and even then it must be in packages of size and weight to suit him, or he will not deign to touch it.

THE GROWTH AND DEVELOPMENT OF THE STEEL RAIL IN AMERICA.

By H. G. Prout.

II.

THE rails designed under the influence of the Chanute-Sayre school were developments of the idea that the metal ought to be put where the wheel-wear comes, which seems a reasonable notion, and which naturally prevailed until people began to collect, analyze, and generalize many of the facts of service. It gradually became apparent, to the astonishment of the world, that these heavy rails with big heads actually did not wear as well as the early steel rails of light section with small heads. When it was found that the old John Brown rails of the Welch section would wear out two of the modern deep-headed rails, there was endless speculation as to the reason. A favorite doctrine with many really good engineers was that the light sections were flexible, and gave way under the wheels; did not offer so much resistance; did not receive blows as an anvil receives them; and so on.

Slowly the facts were established that a very small percentage of the rails that failed did so from the wearing off of the surface on the top. They failed because they wore rough, or because they broke; the heads were split down, and the ends battered out. They did not stay in the track long enough to wear out. Studies of etched sections of broken rails, investigations into scrap-heaps, chemical analysis, and physical tests finally established the fact that the new rails were physically softer, irrespective of chemistry, than the old rails with small heads; that they were less homogeneous, and that the metal was not so thoroughly worked. Pipes and blow-holes in the ingots remained as flaws in the interior of the rail-heads. It came to be well recognized also that the great mass of metal in the head cooled much more slowly than the thin flange; consequently, in the final passes, the head was worked at a high heat, and the flange at a low heat. The slow cooling of the head established curves, and it was impossible to give the rail just the camber that would cause it to cool straight. Therefore the rail had to be straightened in the mill by gagging. But gagging is a cruel process; it is likely to put two little curves into the rail in place of one big one. It forcibly changes the tension in the material, and the rail leaves the mill straight, not because it is its nature to be straight, but because it has been distorted

into approximate straightness, full of all that contrariness which engineers call internal strains. So the next thing that happened was the restoration in the track of some of the crookedness taken out by the gagging, and this in turn led to breaking under the blows of driving-wheels.

Then came forward the school of doctors headed by Dudley, Hunt, and Hawks, who insisted that Holly and Welch were nearer right than the later designers, and that the rational form of rail-section was one in which the weight of metal in the two main members is balanced as nearly as may be. Dudley's 80-pound rail of 1883 (Fig. 11) had 45 per cent. of the metal in the head, 20 per cent. in the web, and 35 per cent. in the flange. Hawks's rail of 1889 (Fig. 12)—also an 80-pound rail—had 42 per cent. in the head, 22 in the web, and 36 in the flange.

For a number of years this part of the principle of rail-design was a matter of lively discussion. Mr. Dudley and Mr. Hawks thought, and worked, and produced rails, and wore them out, and did not say very much, but what they did say was to the point. Captain Hunt was persistent and insistent in his brief and pungent papers before the societies. In 1889 Captain Hunt had brought out his series of sections, the general characteristics of which are shown in the Hawks section, and in 1893 the committee of the American Society of Civil Engineers brought out the series of standard sections varying by 5 pounds and running from 40 pounds up to 100, the general principles of which are seen in Figs. 14 and 15. Here the distribution of metal is practically identical with that of Hawks's 80-pound section. The crown radius is 12 inches, the upper corner radius is $\frac{5}{16}$ of an inch, and the width is $2\frac{7}{16}$ inches. The head is broad and thin. This committee consisted of eleven members of the society, all prominent, and included Mr. Hawks and Captain Hunt, who had the satisfaction of seeing their ideas prevail, but not without a struggle. There are several stout representatives of the older theories on the committee, and the ultimate agreement was not reached without a good deal of the most careful and solid discussion and consideration. When I say that this series is the standard of the American Society of Civil Engineers, do not misunderstand me. It has been the policy of that society, not to fix standards, but simply to recommend them. What the society did in this case was to collect material, encourage discussion, and approve, finally, the set of sections presented by the committee, and the use of these is now the practice recommended by the society. Really, they must stand and fall on their merit.

But there is another element that enters into the design of the rail

section—its stiffness as a beam ; and stiffness is very important. I am inclined to think that, if the road could be made absolutely unyielding, the springs of the vehicles providing the elasticity, the best results would be had. If the track could be as smooth and relatively as stiff as a planer bed, there would be a saving in the cost of maintenance of track and machinery, and in coal-consumption. The stiffer the rail, the less the creeping due to the wave which runs ahead of the wheels, the less the wear of the ties due to this motion ; the less the destruction to track and running-gear due to the pounding of the wheels ; and the easier the hauling of the trains. Mr. P. H. Dudley, who has made careful measurements of tractive force with a dynamometer, says : "Instead of making rail sections simply heavy, I have made them very stiff, which has reduced the deflection, or wave motion, under each of the wheels. Comparing the resistance of the Chicago limited express on stiff 80-pound rails with that on 65-pound rails, it makes a difference of 75 to 100 h. p. per mile." He designed some rails of 105 pounds nearly 100 per cent. stiffer than his 80-pound rails, and estimated that on fast express trains he would save nearly 200 h. p. per mile as compared with a worn 60- or 65-pound rail. If we admit, then, that it is desirable to make the rail as stiff as we can with a given weight, it follows that the section should be such as to give relatively great depth, to distribute the metal somewhat equally between the members, and to put the strained fibres as far as possible from the neutral axis.

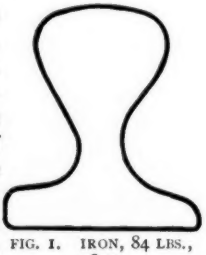


FIG. 1. IRON, 84 LBS., 1875.

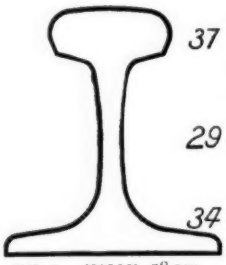


FIG. 2. HOLLY, 58 LBS., 1858.

Now let us again go over this matter of the small railhead, for there are some points which I wish to make very clear. They are the controlling elements in the modern theory.

First, it gives with the same weight of metal a stiffer section, because the beam is deeper and the members have more nearly equal areas.

Second, the small-head rail cools straighter, for the masses of metal are more

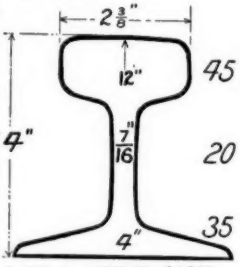


FIG. 3. WELCH, 53 LBS.

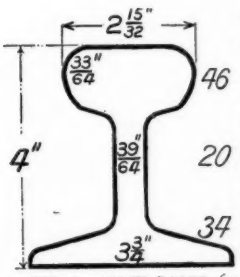


FIG. 4. MANY ROADS, 60 LBS., 1870.

nearly equal; thus we get rid of internal strains, and of the kinks introduced by the gagging press.

Third, with the same chemical composition we get a harder and tougher head, for the metal is worked down more in the rolling. The forging effect is obtained all through the mass. This, too, helps to eliminate the defects of piped ingots. There is a better chance that the walls of the cavities will be closed and the traces of pipes and blow-holes disappear. But one should not rely too much on this. The best way is to see that the ingots are sound to begin with.

Fourth, the reduced mass in the head leads to the very important result of making the final passes through the rolls at a low temperature. Steel is a beautiful and useful metal, but it must be treated with great judgment. Robert Hunt, whose life has been spent in trying to get good steel rails made (and it has been a life of great energy directed with singular intelligence), once said: "The metal commonly known as steel is almost as sensitive to treatment as a woman. It will stand any amount of punishment, if administered by judicious hands, and unexpectedly rebel, if a less amount is given with indifference." I think I might make this further parallel—about steel and women the more you know the less you know. But the modest and painstaking and persistent inquirer can learn some things about steel at any rate. Such an inquirer has been Mr. Metcalf, of Pittsburg, past president of the American Society of Civil Engineers, and past master in the art of steel-making. In a beautiful paper on steel, read before the American Society of Civil Engineers in 1887, Mr. Metcalf says: "It is well-known that the whole structure of the ingot or casting varies decidedly with the temperature at which the metal is poured. It is not so generally known that in every piece of steel that is in existence to-day there is a sure record of the last temperature to which it was subjected, as well as of the manner in which the steel was worked. For every variation of heat that is visible to the naked eye, there is a corresponding variation in structure which is equally visible to the naked eye if the record be opened by

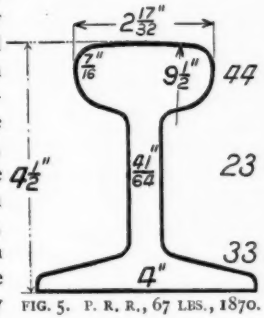


FIG. 5. P. R. R., 67 LBS., 1870.

fracturing the piece. There is also a different specific gravity for each difference of structure. There is, of necessity, a permanent internal strain for every variation in specific gravity, because each change in specific gravity means a corresponding change in volume. These strains vary from the slightest up to those that produce rupture. A piece of 58 carbon steel will vary in specific gravity from 7.844 in the bar finished at ordinary red heat to 7.818 in the bar cooled from a scintillating heat—a difference of .026. A bar of 1.079 carbon under the same conditions will vary in specific gravity from 7.825 to 7.690,—a difference of .135. This shows that for a double quantity of carbon we have five times the difference in specific gravity, due to an equal difference in temperature. Every piece of steel is at its best in all physical properties when the grain is in the finest condition possible, or its crystals are the most minute and uniform size. The largest crystals and the coarsest and weakest structure are formed when iron and steel are allowed to cool slowly and in a state of rest, and the finest crystals and the best structure can only be formed by quick cooling and the violent agitation of the hammer or of the rolls."

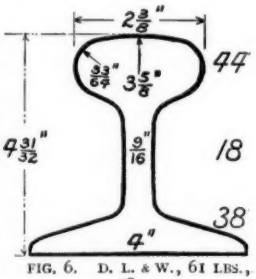


FIG. 6. D. L. & W., 61 LBS., 1874.

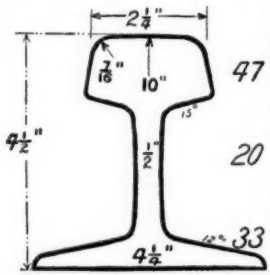


FIG. 7. CHANUTE.

All of this means that, if we want a compact, hard, tough, homogeneous steel, its final working must be at a low temperature, or, as Mr. Metcalf says, it must cool quickly and during the violent agitation of the hammer or the rolls. This means also that the harder the steel is chemically,—that is, the higher it is in carbon,—the greater the effect of this low temperature at the final passes. And here is one of the occult, but unquestionable, benefits of making the head of the rail small,—a benefit which has been suspected only in very recent times; the mass is so small, relatively, that the metal cools quickly, relatively, and cools while it is still un-

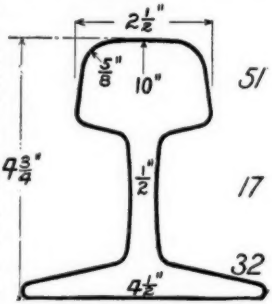


FIG. 8. P. R. R., 75 LBS., 1885.

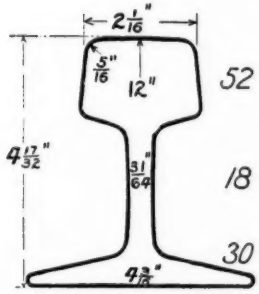


FIG. 9. C. C. C. & I., 65 LBS., 1885.

dergoing the agitation of the rolls. It becomes, therefore, dense, compact, and homogeneous. All of this is illustrated in the story of the 95-pound rail designed in 1890 by Mr. P. H. Dudley for the Boston & Albany. The chemical specifications required 60 points of carbon, 80 to 90 of manganese, 10 to 15 of silicon, not more than 6 of phosphorus, and not more than 7 of sulphur. The proportion of carbon was thought very high for American practice, and there was some doubt as to the possibility of getting a tough steel with so much carbon. Thanks to the careful manipulation, but still more to the intelligent proportioning of the section, a steel, not only chemically hard and physically hard, but remarkably tough, was secured. Two thousand pounds falling 20 feet rarely broke the specimens, while many hundreds stood from two to four blows of 2,000 pounds at 30 feet with supports 4 feet apart. When tested under the drop falling on one side, the lower edge of the flange gave an elongation of 16 to 18 per cent. Specimens from these rails gave a limit of elasticity of 55,000 to 60,000 pounds. This was not only hard, but tough, steel. The New York Central had already adopted the Dudley sections as standard, and, as a result of the experience with the Boston & Albany 60-carbon rail, the New York Central has now adopted 65 to 75 points of carbon for its 100-pound rails and 50 to 60 for its 75- to 80-pound rails.

While the most important principle fought for in this later battle of the sections was such a distribution as would insure more thorough working down of the metal in the head by making it thinner, and would insure more nearly the same rate of cooling, and would make the final passes at a low temperature, and would give a stiff beam to carry the load, there are minor points of considerable importance.

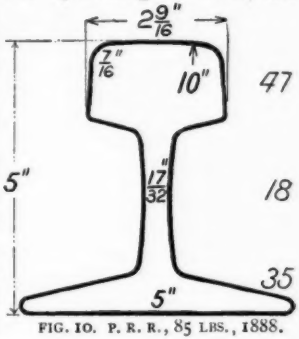


FIG. 10. P. R. R., 85 LBS., 1888.

I asked attention to the matter of the corner radius and the slope of the sides of the head. The large corner radius of half an inch or thereabouts, shown in the earlier sections, was probably adopted without any very careful consideration. At any rate, I have

not discovered the reasons for it. But some years ago a very elegant theoretical reason for it was brought forward. We had the fact, so we must have the theory. It was held that the upper corner of the rail-head and the fillet joining the tread of the car-wheel to the flange of the wheel should coincide, or nearly so, in radius of curvature, in order to give the maximum bearing surface of the one against the other, and to prevent the cutting out of the fillet of the wheel by the sharp upper corner of the rail-head. At first sight this seems plausible, and the theory was soon applied to the side of the rail. At first the rail-head was flared to increase the bearing surface for the fish plates underneath the head, —certainly a laudable practice; but soon the doctors discovered a higher theory to fit the facts,—namely, that, it being a good thing to have the curve of the fillet and the curve of the upper corner of the head fit, it was a still better thing to have the fit extend down the side of the rail, so that the flange of the wheel would come in contact with the side of the rail-head for a considerable depth, thus still further increasing the wearing surfaces, brought in contact. This sounded plausible, and there are to this day intelligent and responsible engineers who insist upon having rails rolled with a considerable outward flare of the head in order to diminish the flange wear of the wheel, and the section shown in Fig. 18 was actually rolled ten years ago. But the fallacy of this theory is easily seen. The friction between the wheel and the rail is changed from rolling friction to sliding friction. So long as the curve of the fillet and the curve of the rail corner come in contact only on a line high up, near the tread, the friction between the two is practically a rolling friction; but, as this contact extends down the side, the flange of the wheel grinds against the side of the rail, and the hard, chilled iron becomes a beautiful tool for cutting away the side of the rail. Furthermore, this flange friction is a serious element in the sum of the resistances of the train.

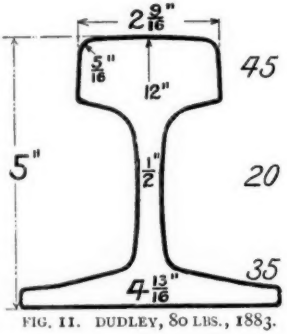


FIG. 11. DUDLEY, 80 LBS., 1883.

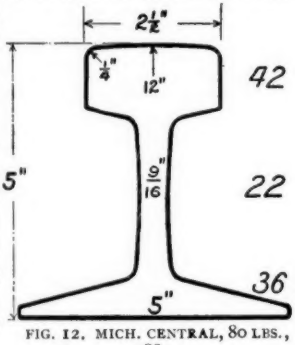


FIG. 12. MICH. CENTRAL, 80 LBS., 1889.

The 12-inch-crown radius has been returned to in the later designs, in order to increase the bearing surface of the wheel on the top of the rail. For years there was a tendency to reduce the crown radius. Mr. Sandburg, an intelligent and influential Swedish expert practising in London, whose work has had much effect on modern rail sections, got down to a 6-inch radius. I should say that 10 inches is the most common in American practice. Recently, however, 12 inches has prevailed, and indeed was considerably used before the Dudley-Hawks-Hunt sections were much talked of. Mr. Dudley uses 14 inches for the crown radius of his heavier sections.

There are those who would make the top flat; among these is Mr. D. J. Whittemore, chief engineer of the Chicago, Milwaukee & St. Paul. For this there are two chief reasons. With a greater area of contact, there is greater adhesion between the driver and the rail, and, further, as the pressure is distributed over a greater area, there is slower wear of the rail and the tire. These points seem obvious; they are matters of observation as well as of theory. With the recent broad heads, with 14-inch crown radius, the life of driving-tires is observed to have been increased, and I do not doubt that the life of the rail also will be increased. A number of experiments have been made, especially by Mr. Chanute and by Mr. Whittemore, and later by Prof. J. B. Johnson, to ascertain the static pressure of a locomotive driver on the top of the rail. This has been done by jacking up the wheel, painting the rail, letting the wheel down, and observing the shape and size of the figure produced. It is a rough ellipse with the long axis across the rail and with an area of from $\frac{6}{10}$ of a square inch to $1\frac{1}{4}$ sq. inches. Mr. Chanute thought that he got static pressures of more than 80,000 pounds per square inch, and Prof. Johnson got 160,000 pounds. But this gives little notion of the effect produced by the delivery of the blow of a driving-wheel in rapid motion on so small an area. It was the prevailing design of rail-head with a sharply-curved crown, tending to reduce the contact between rail and wheel as nearly as possible to a mathematical point, that led Mr. Whittemore to say that every inch of rail contained a blunder.

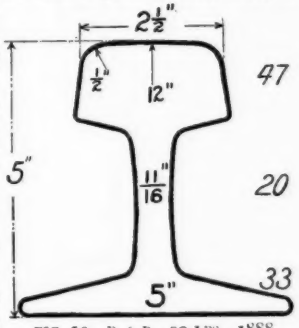


FIG. 13. P. & R., 90 LBS., 1888.

We will now consider the chemistry of the steel rail. In the early days not much attention was paid to chemistry. Early rails

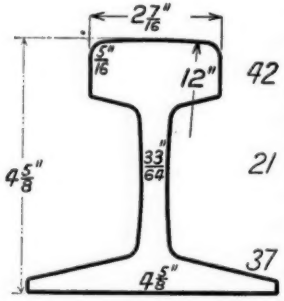


FIG. 14. AM. SOC. C. E., 70 LBS.

which wore remarkably well showed, on analysis, a wide variation. Carbon ran from 24 points to 70 points, and phosphorus from 8 points to 16, but the mill processes were slow and careful. The heads were small; the rails were worked at a low temperature; they came out physically hard and tough. It did not make much difference, therefore, about the carbon, or, indeed, about the other chemical ingredients. As time went on, and the demand rose, and prices fell, the pressure for big mill outputs grew. Less care was taken; rails were finished hotter, and the quality fell off; and then the chemist assumed more importance.

About 1878 Dr. C. B. Dudley, chief chemist of the Pennsylvania Railroad, announced that soft rails were best. His studies were from twenty-five samples of rails taken out of the track, and his critics said that this was too small a number of observations to serve as a basis for a general law. In 1880 or 1881 Dr. Dudley came forward with a second paper, being a long, carefully-written, and ingenious report to Mr. Ely, superintendent of motive power. In this he gave the result of studies on sixty-four rails taken from the track, and his conclusions were that these studies confirmed the results of his observations on the twenty-five rails of three years before,—namely, that soft rails (rails low in carbon) wear longer than hard rails. The practical outcome, so far as he was concerned, was that he recommended for the Pennsylvania Railroad a rail specification as follows: Carbon, 25 to 35, aiming at 30; phosphorus, 10 or less; silicon, 4; manganese, 30 to 40, aiming at 35.

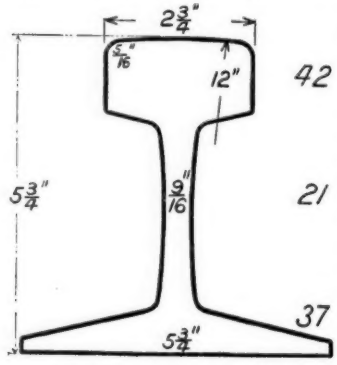


FIG. 15. AM. SOC. C. E., 100 LBS.

This proposition—that soft rails wear better than hard ones—was supported by ingenious reasoning and a formidable display of figures, tabulated in various ways, and really had a good deal of effect on American practice for some years; but I doubt if carbon is ever specified now as low as 30 points. Indeed, I doubt if the Pennsylvania Railroad ever had many rails rolled with so small a

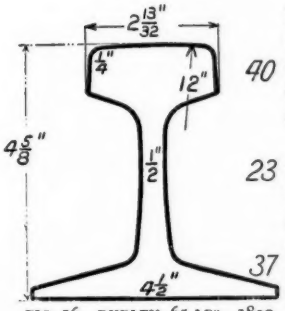


FIG. 16. DUDLEY, 65 LBS., 1890.

proportion of carbon. Certainly, the Dudley specification soon gave way to
40 a specification calling for 30 to 50 points of carbon, and giving a wider range in all chemical ingredients.

But the Dudley specifications made
23 people timid about a high carbon. The fallacies of the theory were pointed out early, but there were good reasons why it was convenient for people to think
37 that soft rails would wear better than hard ones. Ores high in phosphorus are cheaper than ores low in phosphorus, and, with a low carbon, more phosphorus may be used. Then, with thousands of miles of unballasted and badly-drained track, it is desirable to have a soft and tough rail,—that is, a rail which will not break easily; and this need is especially desirable in a climate like that of the United States, subject to severe frosts and violent changes of temperature. Not that a rail breaks because it is cold, but because, in the freezing and thawing of the ground, the supports become uneven. It was more important for many poor roads to have a rail that would not break than to have one that would wear well. Thus, the soft-rail theory had considerable vogue.

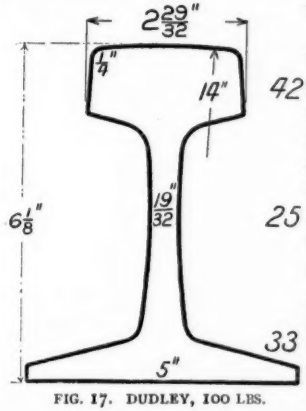


FIG. 17. DUDLEY, 100 LBS.

But the theory was not borne out by experience, nor was it demon-
42 strated by Dr. Dudley's figures. The rails which he considered were not high-carbon rails. In the sixty-four rails there was only one that had more than 60 points of carbon; there were
25 only four that had more than 50; there were only nine that had more than 45; but to-day 50 points of carbon is looked upon as only ordinarily high. A higher carbon is
33 frequently specified, and a rail having only 45 points would not rank as hard. The fact is all of Dr. Dudley's rails were soft rails; they differed only in shades of softness. Furthermore, the differences in carbon were so small that any effect that they could have had would have been obliterated by a dozen other facts in the history or circumstances of the rails. Indeed, the classification had to be so close, in order to divide these rails into two classes of hard

rails and soft rails, that a small error in the work of the chemist who analyzed them would have changed a rail from one class to the other.

I have said that Dr. Dudley's rails were not hard rails; only four of them had more than 50 points of carbon, and only one more than 60. While a carbon of 50 points was considered high ten years ago in the United States, in French practice it would have been very low. The Frenchmen consider no rail hard unless it has 60 points or more of carbon, and they often use 100 points. Mr. Couard, engineer of the Paris, Lyons & Mediterranean Railroad, found, from a study of the rails turned out by four different French mills, that their composition averaged as follows: carbon, 86; manganese, 69; silicon, 15; phosphorus, 5. He compared these with a large number of rails turned out by five German mills, averaging 31 points of carbon and 9 of phosphorus, and found that the French rails wore about twice as long as the Germans.

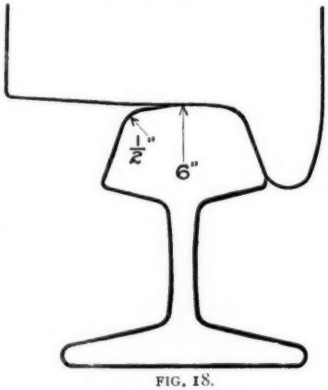


FIG. 18.

But, further, Dr. Dudley's whole comparison might easily have been vitiated, and probably was vitiated, by the difference of service which the rails endured. He made his comparison by total tons carried, leaving out any question of wheel-weights and speeds. But the intensity of the traffic must be considered, as well as the volume of the traffic. A million tons carried over a rail at sixty miles an hour will have a much more destructive effect than a million tons carried at fifteen miles an hour. Furthermore, a million tons carried in heavy loads concentrating the weight on the wheels will have a more destructive effect than a million tons carried in light loads. As a matter of fact, a number of the rails which Dr. Dudley classed as good rails because they had carried their tonnage with comparatively little wear had passed their lives in carrying light loads, while a number of the bad rails had carried twice as many tons per month as any of the good rails.

But all this, without the mill history, without the record of the heat at which the ingot was bloomed and the rail finished, and without its life record in the track, can teach us but little. The fact stands that, together with the increase in weight of section, we see

now a steady rise in carbon specification, and I should not be surprised to see at least 60 points of carbon the rule within a very few years.

It will naturally be asked what measure we have of the life of a rail? How can we tell whether a rail has filled the normal measure of a good rail's life? This is a very hard question. Obviously, its life cannot be measured in years. The section in Fig. 19 was cut from a rail which had been in track eighteen months. Rails from the same lot lived thirteen years in the main track of the same road. The difference was that this unfortunate rail was at the entrance to a great yard, where it had to endure the passage of an enormous tonnage.

But, measured in tons carried, what would be the life of a rail? Here again one may find ingenious speculations. One man says that a rail should carry 100,000,000 tons; another learned man says that it should carry 150,000,000 tons; but, as I have suggested before, this is a question not only of volume, but of intensity of traffic. Again, the life of a rail will doubtless depend somewhat upon the service to which it is subjected when it first goes into the track. If it is used gently for a while, and gets the cold rolling which hardens and toughens its surface before it is called upon to endure extreme service, probably it will wear longer than it would have worn had it been put into intense use at once; and I should not wonder if this was one reason why the early rails wore so well. Capt. Hunt writes to me: "It is fair to expect a trunk-line rail to last ten years. The New York Central has recently taken out rails that have been giving good service from seventeen to twenty years; but these came out of a four-track road." So, I will dodge the question as to how long a rail ought to live.

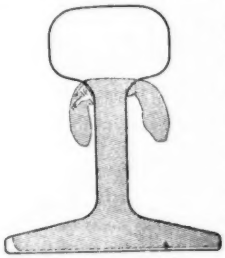


FIG. 19. WORN RAIL.

There is one other matter on which I may venture an opinion,—namely, what is to be the future rail? Fancy sections are invented and re-invented from time to time. Every little while some distinguished or obscure individual comes out with a compound rail, the idea generally being to make it in three pieces,—two lower-flange pieces and the head piece. The objects are, first, not to have to scrap so much material when the head is worn out; second, by laying the three pieces so as to break joints, to get rid of rail joints; third, to make the lower members of a soft and tough steel, and the top member of a hard, but perhaps brittle, steel. I do not hesitate to say that this scheme is nonsense. When we can buy good steel rails at a cent

a pound, we cannot afford to spend much money in making machine-fits and bolting or riveting parts together to save the weight thrown into the scrap-heap, and we have seen that intelligent sectioning gives a rail hard *and* tough. Unless the compound rail is very efficiently made indeed,—much more efficiently than any that has ever yet been put into track,—it will go to pieces in a short time. The last experiment of this sort that I know of was tried in a yard at San Francisco a few years ago, and in a few months the yard sounded like a boiler shop when a locomotive went through it. Steel is too cheap, and good steel is too easily made, nowadays, for one to think of such a device as a compound rail.

Another theory is to make a continuously self-supported rail. This idea has been elaborated with great skill by Mr. Haarmann and Dr. Vietor of the George-Mary Iron Works, in Osnabrück, Germany, and the exhibit of it attracted a good deal of attention at Chicago in the World's Fair. The idea is to make a rail almost eight inches high and almost eight inches wide on the foot,* to be used without sleepers. It is broad enough to get a good bearing in the ballast, and deep enough to make a stiff girder. Moreover, by making the ends unsymmetrical, Mr. Haarmann produces a lap joint, which gives smoothness and stability. Great things are claimed for this rail, and it may come to something. My own notion is, however, that it will not be found economical, at least in the United States, to dispense with wooden ties at the cost of putting so much steel into the rail. Moreover, it will not be found practicable with a longitudinal, self-supported rail to get track so smooth and stable as that given by a reasonably stiff rail on wooden ties. Putting in 16 ties to the 30-foot rail, we get a bearing surface of 85 square feet for 30 feet of track; but, with the Haarmann rail, we have a bearing surface in the ballast of only 40 square feet. With the track on ties we have more than twice the bearing surface in the ballast that the Haarmann rail has. Dr. Vietor was much surprised in the summer of 1893, when he came to accurately measure the deflections of modern stiff American rails in good stone-ballasted track, and he went back to Germany somewhat shaken in his faith in the sleeperless rail. But there is still another objection to this form of rail,—the difficulty of draining the track. The rail supported on ties does not interfere with the drainage. Each space between two consecutive ties allows the water to drain freely away. But with a longitudinal stringer, or with a self-supporting rail and no stringer, it would be difficult to drain the track as promptly and adequately as with ties. For these reasons I question the scientific soundness of the Haarmann–Vietor idea.

* This rail was illustrated in THE ENGINEERING MAGAZINE for April, 1897, p. 50.

Without being ambitious to get the honors and incur the perils of prophecy, I will venture to say that, for many years to come, the standard rail for the United States, and for most of the civilized world, will be much such a rail as we are using now. The section will not differ greatly from what we have now arrived at,—that is, from the Dudley-Hunt-Hawks-American Society of Civil Engineers section. The average weight will very likely be higher than it is now, and the steel harder. I should not be surprised to see 100 pounds per yard common, and 80 pounds the average weight, and 60 points the average of carbon. This rail may be 60 feet long, possibly 90. By making it 60 feet long we get rid immediately of half the rail joints,—the most troublesome part of a railroad track. In fact, the Pennsylvania railroad, the Norfolk & Western, and some other roads, are to-day putting in many 60-foot rails.

In all that I have said, I have but scratched the surface of what seems a very important and interesting subject, and I would not have it thought for an instant that I suspect that I have said the last word on steel rails. I thoroughly believe that the principles that I have laid down are sound, and I should, without the slightest hesitation, stake my reputation upon them if I were in charge of a great railroad; yet I may contradict some of them within a year, for there are few things concerning which human knowledge can ever be absolute, and steel rails are not among those things. In this matter, as in most other scientific matters, it is well to remember Disraeli's advice to the young men of the University of Glasgow. "The secret of success in life is to try, to fail, and to analyze your failures." Mr. Whittemore expresses the same idea in more homely words in the apostrophe to the scrap-heap with which he prefaces his witty and learned paper on cylindrical wheels and flat-top rails. He says: "The scrap-heap, the inarticulate witness of our blunders and the sepulchre of our blasted hopes, the best but the most humiliating legacy we are forced to leave to our successors, has always to me been brim full of instruction." If the young engineer will candidly and courageously, modestly and without pedantry, study the scrap-heap, I think I can predict for him a reasonable measure of success. Whether or not he succeeds in getting money or distinction, that way of meeting the problems of life will secure the respect and esteem of the best men about him, which, after all, is the highest success that we can hope for.

ELECTRICITY IN THE MODERN MACHINE SHOP.

By Louis Bell.

III.—THE NEW PROCESSES BASED ON THE USE OF THE ELECTRIC CURRENT.

ALMOST the first addition made by electricity to the resources of the artificer was the electric deposition of metals, so familiar now that any reference to it seems almost like ancient history. And yet in its day it wrought a revolution in superseding the slow old chemical processes by a method both rapid and cheap. That which before was difficult—*i. e.*, the deposition of a thick, coherent, dense deposit of almost any metal—became simple and easy, so that substantial coatings of metals desirable for their beauty or non-tarnishing properties could be obtained in a practical commercial way.

The result has been the general use of plating in the arts, with great gain in the appearance and durability of a vast variety of manufactured objects. More than this, galvanoplasty has made practicable the reproduction of many things quite beyond the reach of purely mechanical processes,—for example, the duplication of the half-tone plates with which this article is illustrated.

Old as the art is, new applications like the one just mentioned spring up every few years, and it is well for him who flatters himself that "practical electricity" really belongs to the last two decades to stop for a moment and take note of this first great application of electricity to the arts. At present most new applications of the electrotype sort are to the production of novel decorative effects, but in the larger sphere we must not forget that cheap electrical energy has given us cheap aluminum, raising that metal in a few years from the rank of a chemical curiosity to that of a common and useful material, cheap enough for frying-pans and other kitchen furniture, to say nothing of its uses in large construction, which, after all, depend only on skilful alloying. When any other now rare metal becomes specially desirable on account of some particular property, the electric process of reduction is pretty sure to come to the front again, and it behooves the astute manufacturer to keep an eye on it.

In recent years the most important application of electricity to the improvement of our processes of metal-working has been in the line of electric welding.

As is now well known, there are two radically different processes of this sort. One, the arc process developed by Bernardos and

others, simply employs the electric arc as a heating agent. The object to be heated forms one electrode of this arc, while the other may be another object to be heated, or a solid electrode employed simply for convenience. In still another arc process the electric arc is formed between two carbon points close to and parallel to each other, and then driven out into a sort of blow-pipe flame by a magnet parallel to and alongside of or encircling the electrodes. This flame is used much after the fashion of any other blow-pipe flame. In a still newer process the arc is established between the object to be heated and a slightly acid or alkaline liquid in which it is immersed. In this case occurs the tremendously striking phenomenon of a metal bar under water blazing at a white heat, or even melting into fiery drops.

For certain purposes these very beautiful and ingenious methods have proved very useful, but their field appears to be rather limited, ou account of danger of "burning" the metal and general difficulty of regulating the heat, which is really applied on the surface, with sufficient exactness. Extended surfaces of sheet metal can be thus united very readily, riveted joints strengthened by welding, blow-holes in castings successfully filled, and other work done which would be exceedingly difficult by any other method. Used in this way, the arc becomes merely a very cheap and enormously powerful blow-pipe for heating the desired material. The danger of injuring the metal by excessive heat must be faced, but there is a compensating advantage in the simplicity of the apparatus and the ease with which it can be adapted to various purposes.

A rather sensational recent application of the arc is to the needs of the up-to-date bank burglar. It is a well-ascertained fact that a powerful arc, taking, say, ten horse-power of electrical energy, will burn a sizable hole through an inch or so of the hardest chrome steel in four or five minutes, evidently saving the industrious burglar much valuable time and laborious, if not impossible, drilling. The process is fully explained and discussed in its practical bearings in the current electro technical journals.

With sufficient energy at command, the arc can be made to burn its way through material which will turn the best-tempered drill, and now and then the mechanic may be glad to take recourse to it for the purpose.

The most extensively used welding process, which often becomes a valuable adjunct to the metal-worker, is the Thomson method, in which the surfaces to be united are brought together and made the path of a very powerful alternating current. The contact furnishes a rather high resistance, and the great volume of current rapidly brings

the surfaces and the neighboring metal to welding heat. The current is led in by clamps having a large area of contact and good opportunity to carry off the heat, so that the heat is practically confined to the region between the clamps and mainly to the vicinity of the abutting surfaces. When hot, the joint is usually squeezed together, forming a complete union, as strong as a weld can be made. The time taken ranges from a few seconds to a minute or so, while the energy consumed may range from a few kilowatts to fifty or a hundred, according to the size of the work. For an example, two iron bars one inch square can be completely welded in three-quarters of a minute by the expenditure of a little less than seventeen kilowatts. The cost of this power, even at the rather stiff rate of ten cents per kilowatt-hour, would be only two cents, and at the rates for which power could ordinarily be produced would be far less.

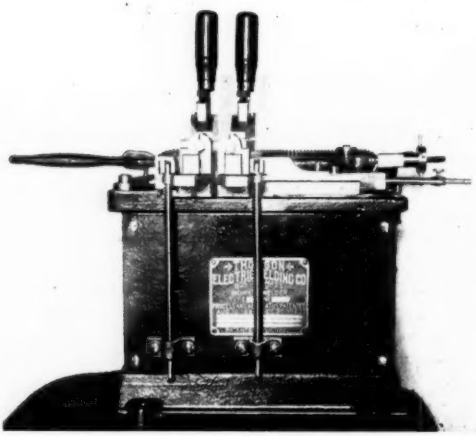


FIG. 1. LIGHT WELDER FOR SHOP USE.

The main objection to the use of this very beautiful process in general metal-working is the need of special clamps for each particular kind of work. When a great number of welds of a certain kind have to be made, the special machinery is worth while, but this necessity is forbidding in jobbing work. Nevertheless, there are a great many metal-working shops where the electric welder could be used with great advantage. The apparatus required is a course of alternating current of low periodicity, say, 40 to 50 cycles per second, a transformer (usually) to furnish a large volume of current at low pressure, clamps of proper shape to hold the work, and regulating apparatus to control the current used.

Fig. 1 shows a light welder for shop use, containing the transformer in its base and capable of being fitted with clamps of various shapes for welding iron or steel up to perhaps half a square inch in cross-section. Such a machine has a very general usefulness, enabling

breaks to be welded, tool steel points to be welded to machinery steel shanks, punchings to be assembled, pins to be welded in, instead of being screwed or riveted, and so forth.

The cheap and perfect assembling of punchings into forms which would otherwise have to be laboriously brazed or solid drawn is one of the neatest applications of the method. Hundreds of thousands of bicycle pedals are thus made, as well as countless numbers of the reinforces with which the tubular frames are assembled.

Fig. 2 shows another "general utility" welder, in which the

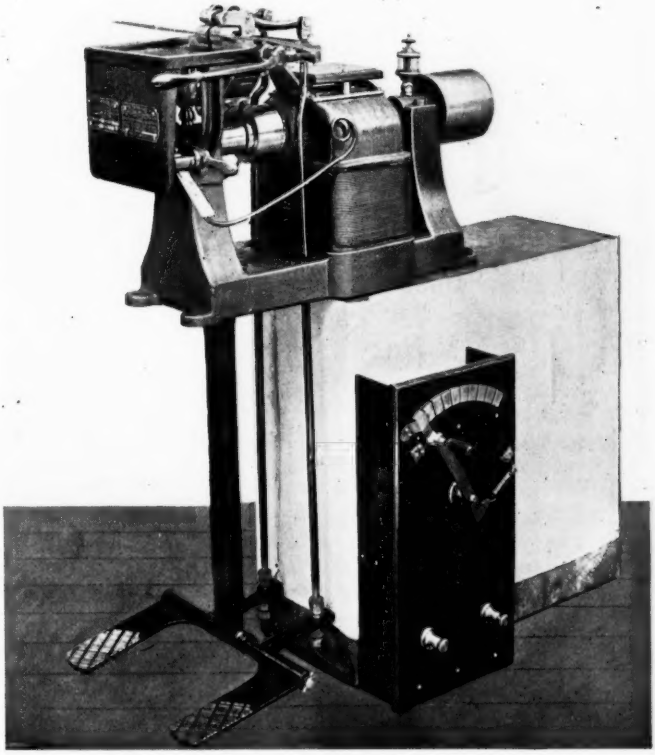


FIG. 2. ELECTRIC WELDER FOR GENERAL WORK.

current is furnished, without the intervention of a transformer, by the small belt-driven dynamo which forms part of the machine. The pedal serves to grip the clamps, and the small handle to compress the weld after welding-heat is reached. The heat can be so nicely regulated that the most difficult welds can be made with the certainty of a good result.

An interesting collateral use of welding apparatus may be found in the application of heavy currents for the local annealing of hardened steel plates, such as are used for safes and the armor of ironclads. The latter case presents enormous difficulties, since the plates are as

FIG. 3. ELECTRIC ANNEALING APPARATUS, CHERBOURG, FRANCE.

hard as nickel and tempering can make them, and so tough that, even when annealed, they are none too easy to drill. In addition, the plates may be a foot or more in thickness. In default of local annealing, holes have to be drilled before the huge plate is hardened, which often causes cracking during the hardening process, and is inconvenient; or the places where holes have to be drilled must be protected from hardening, which is exceedingly troublesome. In the electric annealing process a welding transformer with small copper terminals is used. Placing these terminals on the hardened plate, and passing a heavy current,—10,000 amperes or so,—the plate is locally annealed, so that it can be drilled. The copper terminals are hollow, and a

stream of water is kept running through them to prevent their destruction by the enormous current density used,—say 40,000 amperes per square inch. Such an annealing transformer, with the necessary regulating apparatus, is shown at work in Fig. 3. The scene is in Cherbourg, France, and the extraordinary grain of the tempered armor plate is beautifully shown in the photograph.

It is tolerably evident from the foregoing that electric welding and its kindred processes are rather special than general in their application; but they have, nevertheless, a wide field in constructive metal working. In many large shops a small universal welder, with a good variety of clamps, would find use many times a day, while, if much special work has to be done, the advantage is increased. Aside from this ordinary process, probably the greatest gain lies in the direction of the Bernardos process and its modifications, specially applicable to working sheets of irregular form.

Most curious and interesting are the possibilities of X-ray work in metal-working establishments. One is far from suggesting the establishment of an X-ray outfit in every machine shop, but the process has its uses. The rays had hardly been introduced to the public in earnest before they saved several hundred dollars for a large electric manufacturing concern. It happened in this wise. Nearly a thousand pieces of small apparatus were ready to ship, when it was discovered that, although carefully made and permanently enclosed in their wooden cases, some of the interior connections were bad, the wires having slipped out of place. To take apart the cases, inspect the interior, and assemble again would have cost no small amount; so an X-ray set was put to work, whereupon the interior connections became plainly visible in the fluoroscope. Thus the whole lot was rapidly inspected, and the faulty ones were set aside for repair.

More recently, as X-ray apparatus has been brought into more practical shape, it has been proposed to use it in inspecting metals for faults and blow-holes. Even steel armor plate several inches in thickness can be penetated by the rays, by a very long exposure, sufficiently to show at least all important flaws in the resulting photograph. Moreover, a similar method may prove effective in the minute examination ot the texture of metals supplementing present means of research. Sheets perhaps up to an inch in thickness we may reasonably expect to examine successfully with the fluoroscope. Whether the inspection is by photography or by the eye, as just indicated, the flaws are apparent by the increased translucency (if we may use the word) of the metal. Fig. 4 gives a diagram of the photographic method of examination. From our present standpoint it seems of rather limited applicability, but it certainly gets at the facts in the case, and improvements in

apparatus and methods of getting X-rays, concerning which our knowledge is pitiably limited considering the vast amount of research expended, may at any time raise it to the rank of a method of general utility.

In this work of inspection of masses of metal, electricity can be made to play a most important part. Of course, surface flaws can be detected by the eye, and gross interior flaws by the educated ear and the ordinary tapping process. Both these fail in the detection of minor, yet serious, flaws, and in discovering that lack of homogeneity that may lead to grave results. Take, for example, a great steel shaft. Even if there are no flaws discoverable by ordinary methods, there still may be interior cavities, or even local differences of texture, sufficient to cause a terrible accident.

Such a shaft, however, can, without much difficulty, be inspected electro-magnetically so as to detect and locate even a mere hard spot in the interior, not to say more considerable faults. There are several ways of doing this, but the principle is about as follows. If a round steel or iron bar is surrounded at one end by a coil of wire through which a strong current is passed, the bar is of course magnetized, and the distribution of the magnetic field along the bar follows certain well-defined laws, while it is symmetrical around the bar. Wherever, now, a flaw exists or a part of the bar is even slightly harder or softer than the rest, the distribution of the magnetic field around and along the bar is changed, and this change can be readily detected. Fig. 5 shows the way in which such a field is investigated in the laboratory. Here c c′ is a long iron bar, B is a magnetizing coil near one end, b a small exploring coil slid along the bar, and a a′ are two stops to limit the motion of b. The current induced by suddenly moving b across the lines of magnetic force that issue from the rod between the stops is then noted on a galvanometer. By a similar arrangement the writer has been able to detect so small a local change of physical condition in a long bar as was produced by pounding it at a certain point with a wooden mallet.

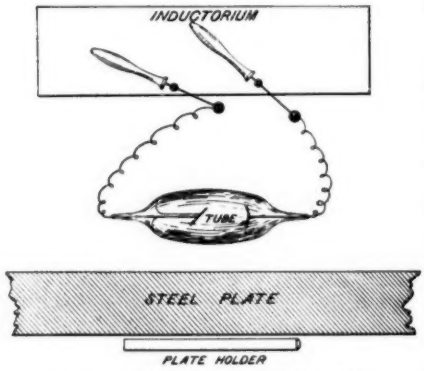


FIG. 4. X-RAY EXAMINATION OF METALS.

Under such a test not only flaws, but points of undue strain, would be plainly indicated, since the magnetic properties of iron are a most sensitive index of variations in physical condition. With proper apparatus even a mass like the shaft of an Atlantic liner could be inspected in the shop quite easily and expeditiously.

Finally comes the electric furnace with all its possibilities in the treatment of refractory materials. It has already given us one new material of great practical value, carborundum, and by means of it we are likely to add considerably to the list of alloys valuable in the mechanic arts. We have by no means come to the end of improvements in material; in fact, there is much to learn regarding even so common a material as steel. The electric furnace putting under control the highest known artificial temperature makes it easy to treat on a commercial scale the most infusible metals and to reduce the most refractory compounds. The opening of a new region of temperature means the acquisition of new and important chemical reactions, and raising old ones to the rank of commercial processes. Out of about fifty metallic elements only a beggarly dozen are used to any extent in the arts; the others are too rare, or too difficult to reduce in quantity, to

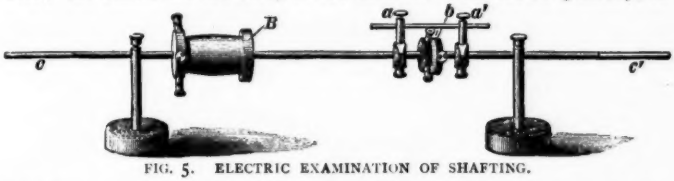


FIG. 5. ELECTRIC EXAMINATION OF SHAFTING.

be of any present importance. There is a great field to be explored,—the same one that has given us carborundum and cheap aluminum,—and, while we may find no new process for the every-day work of the shop, there is an excellent chance for finding new material for the workman, which is of still greater importance. Fancy the result of doing for aluminum what carbon does for iron, or for iron what antimony does in type-metal!

Reviewing now the utility of electrical energy in the work-shop, we find that, of the three functions noted,—*viz.*, saving in power, saving in labor, and saving in virtue of a new process,—the first-named affords the greatest opportunity for immediate economy. It can be utilized without any radical innovations in methods of work, and brings immediate returns. The method of applying the apparatus is straightforward and governed by fairly-well-defined laws.

The introduction of electric labor-saving devices is a matter of ingenious application rather than of well-defined system. The chance for saving is great,—perhaps greater than in the saving of power,—but

the apparatus is mostly specialized, and the greatest economy is attained in special departments of work. Sometimes no important saving can be made, while again there is every chance for good returns. Many of the most useful applications are to work quite outside of ordinary machine-shop practice.

The introduction of new methods due to the employment of electrical energy is a most promising field of wide and varied value. So far as metal-working is concerned, development has been so far along but a few lines, many of the most important improvements having been in collateral lines—electro-metallurgy, and various branches of the manufacturing arts. Some of the applications have been brilliantly successful, as in the adaptation of electric welding to the manufacture of projectiles and other special articles. Others have made but dubious successes. The prizes are great, however, for a new process may mean, not only the cheapening of a product, but the accomplishment of a task hitherto commercially impossible. The saving of power demands the close attention of the engineer; the saving of labor, the *finesse* of the skilled manufacturer; the achievement of a new process, the rare talent of the inventor. The three combined are likely to work a revolution in industrial operations that will be a credit to the on-coming twentieth century.

EARLY STEAMBOATS ON WESTERN AMERICAN RIVERS.

By Cons. D. Millar.

THE Ohio river, from Pittsburg to its mouth in the Mississippi, near Cairo, Ill., has a length of about one thousand miles. Its total drainage area is about two hundred and ten thousand square miles. The total population of the cities and towns situated immediately upon the banks of the Ohio and its principal tributaries is about two millions. Hence the importance of the stream as a highway of commerce is great.

Geologically the formations along the upper Ohio valley belong generally to the sub-carboniferous groups, but at various points on the upper river, and as low down as Brandenburg, Ky., 640 miles below Pittsburg, are found the Niagara limestones—oil- and gas-bearing rocks. The diversity of mineral resources has of itself brought great wealth to the valley, and has proved a great incentive to the establishing of manufacturing enterprises; these in turn have brought population. The coal traffic on this river is greater than all the traffic on the Mississippi, excepting that which it receives from the Ohio.

The first work to improve the navigation of the Ohio was done in 1825. At that time the river was obstructed by snags, rocks, gravel, and sand bars throughout its entire length. The government has been liberal in its appropriation of money for the improvement of the Ohio and its tributaries, as well as in placing beacon lights to assist in navigation during the night.

Safe ice harbors have been formed at various points along the river to give protection for shipping in time of danger from ice.

During 1896 more than eight million tons of freight and more than five hundred thousand passengers were carried by boats. The freight consisted of coal, iron, manufactured products, and general merchandise, and its value exceeded $250,000,000.

The capital invested in boats is, approximately, $8,500,000. The total amount expended on the improvement of the Ohio for the last seventy years is not more than 2½ per cent. of the value of the freight carried on the river in a single year.

The Davis island movable dam, near Pittsburg, has been in successful operation since 1885. A number of other dams are now being constructed. In general terms, the object of the work being done, and of that projected, is to secure, as far as may be, uninterrupted navi-

THE NEW ORLEANS LEVEE IN THE PALMY DAYS OF WESTERN RIVER TRAFFIC.

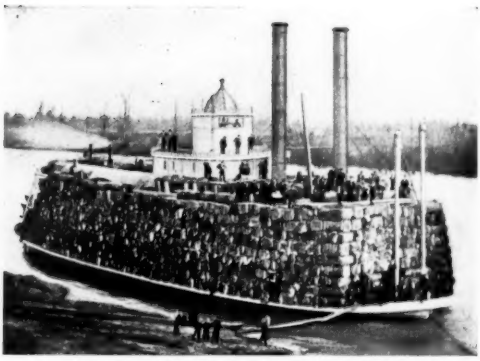
gation with a minimum low-water channel depth of six feet, which is sustained in the harbor at Pittsburg by the Davis island dam during the lowest water.

The annual shipments down the Ohio by steamer average more than 7,000,000 tons, and the number of passengers averages more than 1,600,000. Coal shipments are not included in this estimate. Shipments of logs, lumber, and railroad ties towed and rafted amount to 1,000,000 tons. Of corn, oats, hay, apples, potatoes, cabbages, cider, tan bark, hoop poles, lime, etc., sent by flat-boats, there are 50,000 tons. Of glass and stone ware, dry goods, groceries, oil, hides, pelts,

A GROUP OF "OLD TIMERS" AT THE NEW ORLEANS LEVEE.

oil barrels, scrap iron, old rope, etc., sent by trading boats, there are 15,000 tons.

At the close of the Revolutionary war, the settlement of the Ohio valley began, and with it came the merchant emigrant. His boat was large and well protected from invasion, but otherwise very like the former and still-existing craft, known as the "Kentucky flatboat," built for a cargo of merchandise as well as to carry the passengers who, for a small price paid to the master, were allowed to work their way at the oars, and to fight the Indians if any attack was made. Girty, the notorious white renegade, who led the Indians in their onslaughts,



A COTTON TRIP ON THE MISSISSIPPI RIVER.

being a white and of fluent speech, often induced the unwary boatmen ashore, where they were attacked by his hidden associates.

In June, 1787, James Wilkinson fitted out a small flat-boat, loaded it principally with tobacco, and descended the Ohio and Mississippi to New Orleans, closing out his cargo with good profit. While there, he secured the following peculiar contract:

"This is to certify that James Wilkinson is granted permission to import on his own account, to New Orleans, free of duty, all the productions of Kentucky. He is to furnish tobacco to the king of Spain at $9.50 per cwt. (Signed) "MIRO, Gov. of Spanish Provinces."

This was the first shipment of record, of Kentucky production, but it was followed by increasing annual shipments, until, by the beginning of this century, the trade had grown to mammoth proportions. Then followed the return-cargo system of freighting, and the "Kentucky flat-boats" dropped out of use, except for down-stream transportation.

About that period the Ohio and Mississippi rivers were infested with multitudes of banditti, freebooters, and cutthroats, who, although of white complexion, were no better than the Indians. Many of the leaders of these bands had been early in command of boats with valuable cargoes, and, when so intrusted, never betrayed their trust; but they became debauched by the rough, wild life, and the facilities for evading the law. Living on the lines which divided different civil jurisdictions, they could pass quickly from one to the other and be held amenable to none. From Louisville to the mouth there were few settlements, and it was in this wild country that the depredations upon commerce were committed, Cave-in-Rock and Cash River being the most notorious spots.

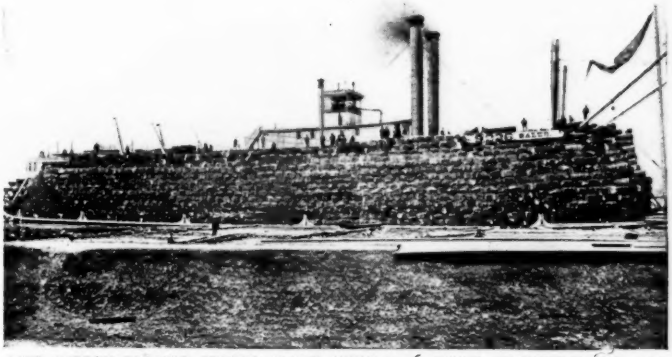
The bargemen or voyagers seem to have been a distinct class; as Audubon wrote, their "fearlessness of character, recklessness of habits, and laxity of morals rendered them a marked people."

The keel boats carried from thirty to seventy-five tons, employed from ten to fifty men, and were provided with a mast, square sail, and coils of cordage, called "cordelles." When the sail was useless, the cordelles were laid; yawls went ahead a thousand feet, where the end of the cordelle would be tied to a tree, and, with the other end upon the barge, all hands would lay hold and pull. By the time the first line had all been "hauled aboard," another had been laid, and the crew were at work again. This work continued from daylight to dark over a space of nearly 1,600 miles, if the trip was to Louisville, and 600 miles further, if to Pittsburg. The down-stream trips were resting-spells for the men, as the current then carried the boats, laden with tobacco, lead, pork, flour, whisky, and other produce. The return trips were another matter. To make the trip from New Orleans to Louisville in three months was considered quick travel.

The passenger packets (carrying limited quantities of merchandise) were propelled by oars, not by cordelles; so also were the barges on the lower river, which carried only merchandise cargoes, and kept pretty well away from the shore to avoid Indian attacks.

Thus the navigation of the Ohio was maintained for twenty years before the use of steam for river navigation.

The New Orleans was the first steam vessel west of the Alleghenies, and was built by Fulton. It was 138 feet long, and of about 300 tons'



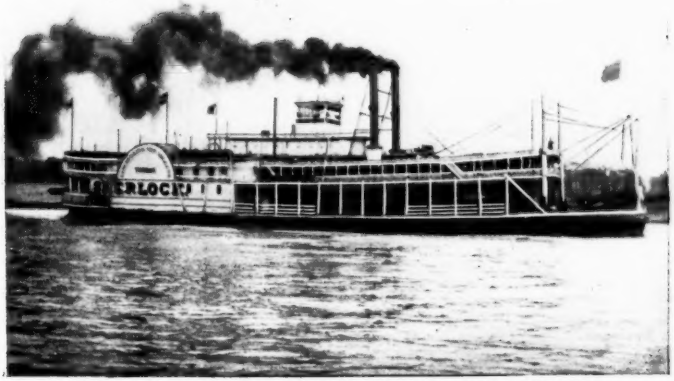
THE COTTON CARRIER HENRY FRANK WITH 9226 BALES OF COTTON AND 250 TONS OF SUNDRIES.

She arrived at New Orleans from Memphis April 2, 1881.

capacity. The people of Pittsburg lined the banks and waved adieus as the steamer weighed anchor, and she soon was out of sight, having shown a speed of ten to twelve miles per hour. On the second night after leaving Pittsburg, she cast anchor opposite Cincinnati. She received a joyous welcome, but all believed, and many declared to A. J. Roosevelt, one of her owners; "Your boat may go down stream, but never can come back; the idea is absurd." She took on a supply of wood, and, after a short stay, left for Louisville, arriving there on the night of the fourth day after leaving Pittsburg. A public dinner was tendered Roosevelt at Louisville. As the river was too low to permit a passage over the Falls, she lay at anchor opposite the

MEMPHIS AND ARKANSAS CITY PACKET KATE ADAMS.

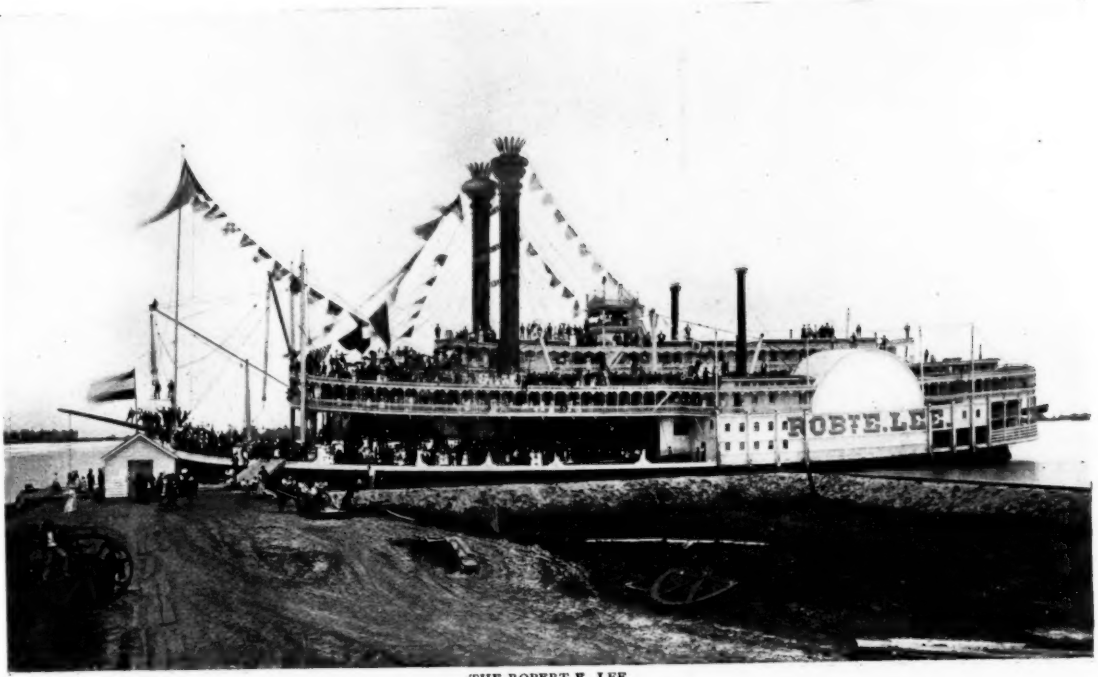
town. Roosevelt, not to be outdone in hospitality, invited his hosts to dine upon the steamer. While the feast was at its height, sudden rumblings were heard, and a perceptible motion became apparent, when all rushed to the guards, believing the steamer had broken her anchor and would be carried over the Falls to certain destruction. They soon found that, instead of going on to the Falls, they were making good headway up stream. After a short trip, they returned to Louisville, a surprised and delighted party. The steamer was built for the trade between New Orleans and Natchez, but, awaiting the expected rise, Roosevelt went to Cincinnati and returned, thus convincing the most incredulous of the vessel's power to stem the current of



THE CINCINNATI AND NEW ORLEANS PACKET THOMAS SHERLOCK.
Totally wrecked in the winter of 1890 by collision with a pier of the C. & O. R. R. bridge at Cincinnati.

the river. The river had risen, and she descended the Falls in safety. While she was going down the river, a large canoe, fully manned, came out of the woods abreast of the steamboat, and paddled after her.

CINCINNATI AND NEW ORLEANS PACKET CHAS. MORGAN.



THE ROBERT E. LEE.

There was a race, but the steam had the greater endurance, and the Indians soon gave up the chase. At New Madrid, Mo., a great portion of which town had just been engulfed by an earthquake, terror-stricken people begged to be taken on board, while others fled from fear. The earthquake had so changed the channel of the river that the pilots made the trip more by luck than knowledge, for the river was full of shoals, snags, and sawyers. The New Orleans had a stern wheel and two masts,—for even Fulton thought sails absolutely indispensable,—and one engine. She continued her packet trips between Natchez and New Orleans until July, 1814, when she struck a snag near Baton Rouge and was wrecked. Her average speed was about three miles an hour up stream. She made several trips to Natchez before the merchants would assume the risk of shipping freight on her, preferring the old slow barges or keel boats. In 1814, more than two years after the building of the New Orleans, the "Vesuvius" was built at Pittsburg. She went to New Orleans in the spring, left New Orleans in July for Louisville, grounded on a sand bar near Helena, remained high and dry for five months, and, when released by the tide in December, returned to New Orleans. Her record offered no encouragement to ship-building.

In 1814 the steamer Enterprise was built at Brownsville, Pa., made two trips to Louisville, and returned to Pittsburg. In December, 1814, she was laden with ordnance stores at Pittsburg for Jackson's army. Gen. Jackson pressed her into the United States service for carrying men, stores, ammunition, &c., to the seat of war. She was released when peace was declared, and, loading for Pittsburg, made the voyage in fifty-four days,—considered a quick trip.

In 1816 a steamer—the first double-decker—was built at Wheeling by Capt. H. M. Shreve. Shreve used French's engines, but placed them in a horizontal position, and gave the vibration to the pitman. He added his great invention, the cam cut-off, and put flues in his boilers, by which three-fifths of the fuel was saved. He named the boat Washington. Leaving Louisville March 12, 1817, she went to New Orleans, discharged and reloaded, and, returning, reached the foot of the Falls in forty-one days. The ascending voyage was made in twenty-five days, including stoppages. This trip seemed to revolutionize the feeling of the public, and created as much excitement and exultation as Jackson's Battle of New Orleans. The citizens of Louisville gave a public dinner to Shreve, at which he predicted that the time would come when the trip—New Orleans to Louisville—would be made in sixteen days. When the Washington arrived at New Orleans, she was seized by order of Fulton and Livingston, who claimed the exclusive navigation of the river to the

U. S. BEACON-LIGHT TENDER LILY, AT COX'S RIFFLE LIGHT, OHIO.

Louisiana line, having been granted that right by the Louisiana legislature. She was bonded, and the case was taken to the United States supreme court, where Chief Justice Marshall decided "that the waters of the United States were free to be navigated by all citizens, and no State could grant exclusive privileges to a company or individual."

Several boats of queer design were built in the years following, among them the steamer Bazabeel Wells, the greatest curiosity of the age. She was built in 1819, with an engine from a flour mill at Steubenville, boiler from another mill at Pittsburg, and a chimney of brick. The first landing she made knocked down her chimney, whereupon she was provided with a sheet-iron smoke-stack.

In twenty years the genius of the United States made such strides in navigation and transportation that the water ways became almost exclusively the routes of travel. About this time the great system of national highways or turnpikes was introduced and rapidly extended, but the river transit had grown to be so restful, agreeable, and comfortable, and withal so speedy, that everybody who traveled went by steamboat.

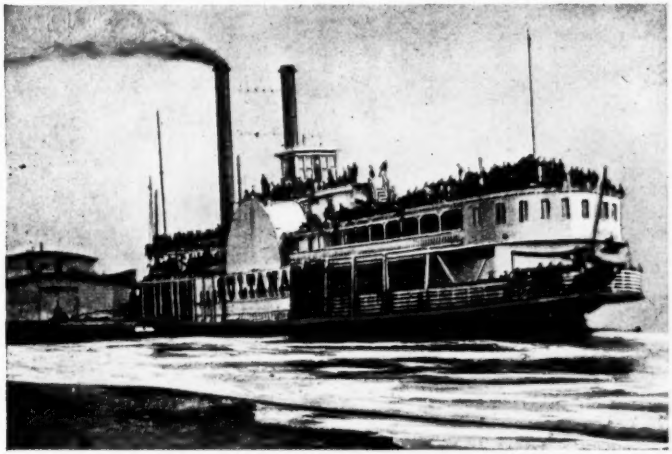
From this time until the early fifties steamboats were built in great numbers; the improvement was continuous, and many of the finest steamers ever constructed were built and placed in commission. The decade of 1850–60 was the golden age for steamboats. Daily lines of fast mail steamers were inaugurated. Prominent among these were

the Pittsburg & Cincinnati line, in connection with the Pennsylvania Railroad, which had just then reached Pittsburg from the east, and the Wheeling & Louisville Union Line, which connected with, and exchanged freight and passengers with, the Baltimore & Ohio Railroad at Wheeling. The rivalry was great, and excitement ran high. Every man, woman, or child along the river had his or her favorite steamer.

The movements of the boats were marked with great ceremony; the crew were full of superstition, and the commanders a law to themselves, and masters of their craft from the pilot-house to the keel.

In the days of the gold excitement in California Missouri river pilots received five hundred dollars a month, work or play. They were all under pay to keep them from standing a watch on outside boats. Similar wages were paid in the New Orleans and Red river trade in the fifties. Now pilots are paid from seventy-five to one hundred dollars a month in the Cincinnati, Memphis, and New Orleans trades.

In the early fifties the Pittsburg & Cincinnati Packet Line consisted of a fleet of fast side-wheel steamers, finely modeled, with big power, but of limited freight-capacity, comprising the Buckeye State, Allegheny, Brilliant, Monongahela, Crystal Palace, Pennsylvania, and Pittsburg; while the opposing boats, known as the "Wheeling &



THE SULTANA AT THE WHARF AT HELENA, ARKANSAS.

The photograph was taken at 10 a. m. on a spring day in 1865. At 2 a. m. the next day the boilers exploded and 1700 persons were killed, chiefly exchanged Federal prisoners on their way home. This was the greatest loss of life recorded in any western American river accident.

Louisville Union," consisted of similar crafts, named the Alvin Adams, David White, Thos. Swan, Baltimore, Falls City, Virginia, and City of Wheeling. To illustrate, we give the dimensions of several of these fast clippers—all side-wheelers.

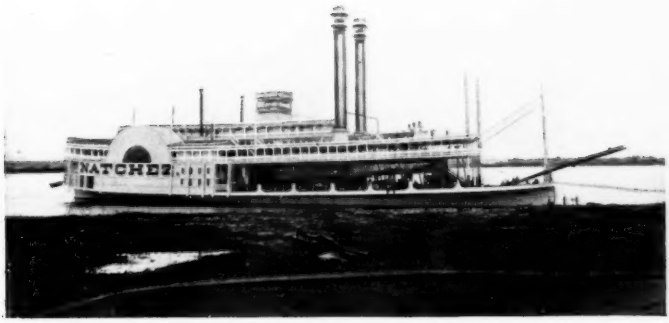
The Buckeye State, built at Pittsburg: length, 285 feet; beam, 30 feet; floor, 28 feet; depth of hold, 6½ feet; capacity, 548 tons; five double-flue 42-inch boilers, 30 feet long; 30-inch cylinders; stroke, 8 feet. The fastest trip from Cincinnati to Pittsburg credited to the Pittsburg line in 1851 was made by the Buckeye State,—490 miles in 40 hours.

The Pittsburg, built at Shousetown, Pa., in 1851: length, 295 feet; beam, 30 feet; floor, 29 feet; hold, 6½ feet; capacity, 650 tons; five double-flue, 42-inch boilers, 30 feet long; 31½-inch cylinders; stroke, 8 feet. Value, $30,000.

The Alvin Adams, built at McKeesport, Pa., in 1853: length, 281 feet; beam, 35½ feet; floor, 33 feet; hold, 6⅝ feet; capacity, 750 tons; six double-flue, 42-inch boilers, 28 feet long; 29½-inch cylinders; stroke, 9 feet. Value, $50,500.

The great low-pressure Jacob Strader, of the Cincinnati & Louisville Mail Line, built at Cincinnati in 1853: length, 332 feet; beam, 37 feet; floor, 32 feet; hold, 7½ feet; two 16-flue boilers, 11 feet

THE R. R. SPRINGER LYING AT THE CINCINNATI WHARF.



THE MISSISSIPPI RIVER STEAMER NATCHEZ.

Grounded at Lake Providence, in the Lower Mississippi; the steamer was lost but her outfit was saved. The present Natchez is a stern-wheel boat.

in diameter and 38 feet long; two puppet-valve engines, 5 feet in diameter; stroke, 10 feet. Value, $120,000. Her boilers, not working well in the muddy water of the Ohio river, were removed, and the old-fashioned double-flue boilers were put in their place. The Strader has the fastest time on record from Louisville to Madison,—43 miles in 3 hours and 12 minutes. The Telegraph, of the same line, having made the fastest time from Louisville to Cincinnati the same year,—9 hours and 52 minutes,—the Strader was not permitted to beat it, though she could have done so easily. The only steamer that claims to have beaten the Telegraph's time from Louisville to Cincinnati is the new City of Louisville, of the same company, which made the run from port to port in 1896 in 9 hours and 40 minutes.

The fastest trips from New Orleans to Cincinnati—1,513 miles—have been made by the following boats, all side-wheel: 1843, Duke of Orleans, 5 days, 18 hours; 1877, Chas. Morgan, 6 days, 11 hours, making 42 landings and losing 3½ hours passing through the Louisville canal; 1877, Thompson Dean, 6 days, 19 hours, losing 14 hours in the canal and 17 hours at way-landings; 1881, R. R. Springer, 5 days, 12 hours, 45 minutes, running time; 1881, Will S. Hays, 6 days, 17 hours, 10 minutes, port to port, having made 51 landings, and met with other delays.

The Dean and Hays had 30-inch cylinders, with a stroke of 10 feet. The Duke of Orleans, like all boats that passed through the old short Louisville canal, was only 172 feet long.

With the present enlarged canal, the boats now in use are longer and of lighter draft, with more than double the capacity, enabling the Upper Ohio to compete with the Lower Ohio and Mississippi steamers.

For general freight-business, economy, passenger-comfort, and speed, the stern-wheel is fast taking the place of the more expensive side-wheel steamer on the Ohio and Mississippi and their tributaries. They make the same time in all packet trades, and, in comparison with the old side-wheel packets, carry twice the cargo with less power. In the New Orleans and Lower Coast trades, the stern-wheel steamers, Natchez and T. P. Leathers, are a great success. The same may be recorded of the packet lines on the Upper and Lower Ohio, the Cincinnati and New Orleans, and the St. Louis and New Orleans trades. The Anchor Line has recently built the stern-wheel Bluff City for the St. Louis and New Orleans trade, and she has proved a great success. A new and magnificent freight and passenger steamer, the Queen City, will soon be ready, at Cincinnati, for the Cincinnati and Pittsburg trade. She will make weekly round trips, carrying as many people, and more than twice as much cargo, as were carried by the celebrated side-wheelers in the fifties. Most of the timber used in the construction of the Queen City is Oregon fir, lighter than oak, but little heavier than pine, and more durable. Her length is 235 feet; beam, 44 feet; depth of hold, 6½ feet; capacity, 1,400 tons; four boilers, 47 inches in diameter and 26 feet long, containing six flues each, allowing a steam pressure of 166 pounds; cylinders, 24 inches in diameter; stroke, 8 feet, equal to 2,000 h. p. She will have all steam and electrical improvements, automatic steering apparatus, and steam and water works pumps, carrying a constant supply of water to all parts of the boat. The state-room panels will be finished in mahogany, and the skylight ceiling of the cabin with pressed steel in high-relief work beautifully decorated in blended colors. She will be brilliantly lighted throughout with incandescent lights, and a beveled-edge French plate mirror will be placed in each state-room door. Her carrying-capacity will be equal to that of three average freight trains, yet she will not draw more than 26 inches of water. She is adapted to any trade along the Ohio or Mississippi rivers.

The famed City of Louisville,—noted as the "Kentucky Greyhound,"—built at Jeffersonville, Indiana, by Howard, for the Louisville & Cincinnati Packet Line, is a side-wheeler, and very fast. Commodore F. A. Laidley, general manager of the line, kindly furn-

ishes the following official memorandum of this steamer: capacity, 1,142 tons; length, 301 feet; beam, 42 feet; depth of hold, 7 feet; built, 1894; eight boilers, 26 feet long and 42 inches in diameter, containing two flues 15 inches in diameter; cylinders 30 inches in diameter; stroke, 10 feet; wheels, 36 feet in diameter; time, down stream, Cincinnati to Louisville, 5 hours, 58 minutes; up stream, 9 hours and 40 minutes, fastest on record, made April 5, 1896.

The rapid decline in steam boating on the western American rivers is attributed to the rapid increase in railroads and the diminution of the water-supply. The government has awakened to the fact that the waterways must be cherished, and the navigation of prominent streams made continuous and permanent. This is now being done by the construction of the chanoine dam, which can be raised or lowered in a few hours, thus not interfering with navigation when nature supplies the volume of water, but furnishing a guarantee of steamboat transit, except when ice prevails. Last year congress appropriated more than $11,000,000 for the maintainance and construction of these betterments. The bill was vetoed by the president, but passed over his head. This improvement established, the Ohio valley must become the coal-producing center of the world. England's coal-supply is limited. The almost limitless coal fields of Pennsylvania, West Virginia, Ohio, and Kentucky, being adapted for rehandling and for foreign shipment, can supply the demands of the world for ages.

Under the old *régime*, 20 men handled a pair of boats, containing 20,000 bushels of coal, to Cincinnati from Pittsburg, time averaging 10 days. The cost of boatman's labor alone was about three cents a bushel. To-day the same number of men, with a steamer, will bring to the Cincinnati market 200,000 bushels at a cost of one cent per bushel for boatmen's labor. The steamer Joseph B. Williams, from Louisville, recently arrived at New Orleans with 1,500,000 bushels of Pittsburg coal. To transport this by rail would cost $3.50 per ton; river transportation costs 50 cents per ton. With the building of the canal from Pittsburg to the Lakes, the locking and damming of the Ohio river, and the construction of the Nicaragua canal, Pittsburg coal can be sold in San Francisco at $4 to $5 per ton, where other and inferior coal is now selling at $7 to $8. American coal could be sold at Callao on the west coast of South America at $5 per ton, where it now commands $15. In Valparaiso, where other nations control the coal trade, United States coal could be furnished at $5 to $6, while now the price varies from $12 to $13.

The editor expresses thanks to Mr. C. H. Hugger, of Owensboro, Ky., for the loan of the photographs from which the illustrations accompanying this paper were made.

THE CARE AND OVERSIGHT OF THE POWER PLANT.

By T. Carpenter Smith.

IN looking over the list of modern inventions, one is struck by the continuously-increasing speed with which developments in the mechanic arts are commercially adopted. In nothing is this better shown than in the now almost immediate acceptance by the world at large of methods and applications which a few years ago would have met with strong opposition, critical examination, and finally a grudging acquiescence. Comparing the relative time in which the general adoption of the electric telegraph, the telephone, the electric light, and electric power were brought about, we see that the number of months required for the development and adoption of the telephone was smaller than the number of years required for the development and adoption of the telegraph. Almost as soon as the electric light was heard of, there was talk of the immense strides which it was making. And electric power had hardly been suggested before it became an accomplished fact.

For years uncertainty of the electric light was looked upon as natural and to be expected; the most annoying failures were met with a good-natured shrug. The trite remark that "electricity is only in its infancy" was a sufficient excuse for these annoyances; but, with the revolution wrought by the electric railroad in city transit, there has come a complete change in the attitude of the public. When the power shuts down, the sentiment is no longer that "blessings brighten as they take their flight." Public dissatisfaction finds an expression in the query: "What is the use of granting monopolies to those who don't know how to treat the public decently."

Comparatively few persons realize the care, patience, and technical skill required to properly handle the latest developments of electric power. Nearly every other business has some one dominant condition, but the power station is controlled by several very diverse ones. To understand and successfully direct any one of a large selection of small manufacturing industries is generally thought sufficient for one man, yet the power-station manager must know and satisfy the needs of all. Time will develop a sufficient supply of men fitted for this particular calling. Meanwhile there are many men who, having but moderate experience in one or more of these lines, can only try to do their best. It is for such men that consideration is particularly needed.

The duties of a general manager or general superintendent lie in two directions; first, toward superior authority, and, second, to the work in charge. Dealing with superior authority is purely a question of individual tact. It is intensely disagreeable and annoying to receive orders or make explanations to a board of directors or executive committee consisting of men who, perhaps, are totally ignorant of the business, its machinery, and its difficulties; yet it must not be forgotten that these men have responsibilities, and must account to the stockholders for the use or misuse of their property. The superintendent should, therefore, cultivate the art of so explaining technical matters that those who know nothing of technicalities may understand; above all, he must never avoid questioning, or attempt to conceal facts. It is not wise to offer too much information as to details, especially where details may entail expense, but, if there is a manifest desire for further information, a straight and reliable account of the matter is the wiser course, since business men, as a rule, will far more readily forgive mistakes than concealment or deceit. Many a man's hair has been made grey before its time in steering a judicious course between this Scylla and this Charybdis.

It has always seemed to me that the most important detail of the power station is, without question, the men employed. Many of the questions or conditions governing the economical performance of the machinery have been settled definitely in the shops of the manufacturer, but the manner in which the machinery is handled, while the most uncertain element, is the element which affects general results in the greatest degree. Until we have trained men who are competent to do any part of the work about a power plant, it will be necessary to have in the station different gangs,—one set for boilers, another for engines, perhaps a third for dynamos, and so on.

When a new industry increases with marvelous rapidity, there is always a lack of men to take the responsible positions, more especially when the industry, as in this instance, deals with principles that are commonly but little understood. The difficulty created by this want of trained men is intensified by the rush into the trade of two classes, each with peculiar limitations. One class consists of men who know how to do the manual work themselves, without the ability to put their knowledge into words for the benefit and instruction of others, and who know little of the more scientific side of the art; the second class includes men who are fully acquainted with underlying principles and can clothe their ideas in suitable words, but who have no knowledge of the actual machinery used, or the conditions which may arise under which it may have to be worked. This has led to antagonistic feeling between the so-called practical man and the theorist, each

underrating the importance of the other, and magnifying the proportion which his share of the work bears to the whole.

In selecting men for the more important subordinate positions, the best workman may be found to make a very bad foreman, and *vice versa*. A man may be a first-class director of work who has himself very little individual skill; in fact, a good mechanic who has executive ability is decidedly a *rara avis*. The average good workman never recognizes this fact, and often feels aggrieved at the promotion of one who, as a workman, is his inferior.

The first principle to be thoroughly drilled into all hands, from superintendent to oiler, is loyalty to the interests of the company. No personal antagonism or aim can be allowed for one moment to interfere with this, and any conduct which tends in this direction must be made the unpardonable sin.

Only second in importance is the principle that a power station is a public servant, and that even the appearance of wishing to dictate to the community must be avoided. There is no customer whose trade is so valuable as that of the general public, and there is no customer who has to be as carefully and anxiously studied, and who is more influenced by feeling and sentiment. There are the two classes of dissatisfied people,—those who are honestly dissatisfied because they cannot see the purpose of many of the rules necessary in dealing with the conditions of a new business, and those who always try to take advantage of any contract. It sometimes requires the patience of Job to give a good-tempered explanation even to a reasonable man; the impossibility of pleasing the dishonest is additional cause for keeping all the friends one can.

One factor in the management of a power plant which has seldom been sufficiently recognized is the tendency of men to take good care of machinery which they personally like, and to neglect or abuse that against which they have some prejudice. This tendency is dangerous. Those in authority cannot guard too carefully against even a suspicion that they have a prejudice for or against any machine. It is one of the few pleasures in the life of a station superintendent to find a man governed by the principle that his duty is to get best possible results out of the machinery he attends, who wastes no time in grumbling or in explaining how much more efficient some other kind is, and who prides himself that he is getting better returns out of that particular machinery than any one else.

The average workman is, in most cases, opposed to the use of a plant which requires him to find out anything for himself. No amount of information given in circulars or catalogues is one-tenth as effective as an object-lesson on the thing itself by some one familiar with it,

who can show him the easiest and quickest method of adjustment or operation. One has to be patient with this, since it is as much a matter of training and practice to acquire information from reading, as from a drawing or diagram. The average machine-tender has not usually the opportunity for such training.

It is most difficult to enforce in a large body of men perfectly even-handed discipline, and yet there is nothing that is more absolutely required for good order. It seems proper to forgive some occasional lapse from good behavior in the man who is ordinarily better and more capable than his fellow-workmen, but to do so will certainly and quickly lead to jealousy, and that indefinable clannishness which forms the dry rot of a station force.

From highest to lowest there must be a well-marked grading of authority, and the men must be shown that the object of this is not to prove one man more of a favorite or better than another, but simply to make it easy to settle responsibilities, since, in all cases of accident or emergency, the man highest in authority on the ground is the man to whom all must look for orders, and it must be known at once who this man is. This is not always an easy matter to arrange. It is governed largely by the circumstances of the station, and whether the men are in distinct departments or not; so that to determine where the duty or authority of one gang ends and that of another begins sometimes requires not a little careful study. I have heard of a housekeeper who, when quarrels arose between servants, would decide who was right or wrong by simply inquiring where the quarrel took place. If it occurred in the kitchen, the cook was in the right; if it occurred outside the kitchen, the house-maid was in the right. In a large electric-light station there was, at one time, a continual friction between the engine men and the dynamo men, taking the form of disputes as to who had authority to order the engines or dynamos started and stopped. The dynamo men would signal for a particular machine to be started up, knowing that the engine was not ready to run, and calling for that particular machine only in order to have ground for complaint. Again, the engine men in the middle of a run would suddenly shut down an engine, doing this when they knew that the dynamo men had no other machines ready to take the place of those thrown out. Both parties were good men, who had become a little wrong-headed, since each thought the other trenching on his neighbor's domain. After some cogitation, the matter was stopped by the superintendent, who laid down the law that the dynamo men had absolute authority to decide which dynamos should be started, and when. The engine men were always to have the engines ready for operation, and must never refuse to start them without good reason, for which they

would be held responsible. On the other hand, the engine men had the right, at any time when machines were running, to shut them down, first giving notice to the dynamo room, and stating what other engine was in condition to run. For this they were also to give good reason, while the dynamo men were expected to have the dynamos always in proper condition to run, to prevent useless delay. The natural result of this ruling was seen in a few days. Neither side could get the other into trouble, but both sides were very much on the alert not to be caught napping.

A careful log kept in each department is practically a necessity. One of the more easily-combatted difficulties encountered in enforcing this is the dislike of writing or figuring by men unaccustomed to it. This can be met by forms which are practically skeleton reports, requiring only the marking of a number or a few words in places designated. The fear that reports are in some way a comparative test of ability or diligence, and the unwillingness to submit to anything that looks like such a test, is in exact, but inverse, ratio to the caliber of the individual.

The introduction of recording meters of all kinds has very much simplified the question of records, but it has introduced another set of machines or instruments to be watched and calibrated; like safety valves, these meters are to be trusted only when regularly tested.

Passing from the human to the mechanical part of the plant, we begin naturally with the boilers. It is more in the boiler room, perhaps, than in any other part of the plant that money is made or lost, and mostly between the coal-pile and the stop valve. One constantly hears of the wonderfully-skilled engineer who saves his salary every year, but his opportunities for waste or economy are small beside those of the fireman. An engineer may examine and readjust a valve once a week to produce a trifling economy of steam, but the fireman practically makes an adjustment with every shovelful of coal he pitches; and, while we find the engines, dynamos, etc., all regulating automatically for changes of load, the cases where automatic regulation is applied to boilers are comparatively few. Engines can practically be shut down at any moment, and stand idle for an indefinite period without loss; but each time a boiler is thrown in or out of service there is waste of coal and labor in starting a fresh fire or drawing the old one.

Probably the most important item is the care regarding feed water. Water varies very much in different localities, and careful analysis is required to determine just what means must be used to counteract particularly injurious ingredients. After every precaution, and when the trouble has ceased, it may appear again in some entirely

unexpected way. An engineer who had been advised to use kerosene in boilers to prevent scale had great success with it for years, when suddenly his boilers began to scale badly; after months of patient and wearing investigation, he found that the difficulty was due to a gradual change of working pressure from one hundred to one hundred and fifteen pounds per square inch. The scale-making ingredients of this particular water at the heat due to the lower pressure would not bake hard, but would form a sludge with the oil and be easily blown out, but at a slightly higher temperature they would cake, and burn on to the tubes and headers, seriously interfering with the steaming of the boilers. Scale is a mild and open enemy, however, compared with pitting and corrosion. After all, no precautions can take the place of constant, systematic, and careful inspection, both internal and external, of each boiler in turn, at times when the boiler and its setting are cool enough for deliberate work.

The selection of fuel is no more of a problem in the power station than anywhere else, but the keeping of a supply on hand to guard against storms, strikes, or break-down is often a serious difficulty, particularly if the fuel called for by local conditions is of a kind which deteriorates by keeping or by exposure to weather, and is thus found unreliable when most wanted. As the final proof of a fuel is in the burning, it is sometimes necessary to arrange the fuel bins to hold a several days' supply, the fuel for use being always taken from the bottom, and the new put in at the top. In this way any poor fuel delivered is speedily found out,—not left to be discovered in time of distress. It is also well to have duplicate bins, using from No. 1 and delivering into No. 2 until No. 1 is emptied, and then making this last the delivery bin, and using out of No. 2 until empty; thus an accurate account can be kept of amounts of each shipment. In order to decide which is the best fuel, many things have to be considered besides first cost per ton. A smaller percentage of ash will sometimes make a higher-priced coal the cheaper. A careful hourly record should be kept of every pound of coal burned, and also of the output. In one station the firemen were repeatedly detected in "cooking" the records,—generally by entering less than the amount of fuel used under the idea that this was in some way a proof of their skill. It was a great puzzle to them that every time they did this they were immediately tripped up. They were not versed in the mysteries of "fuel per unit of output," which the manager worked out from the dynamo-room records, and so they would occasionally hand in reports showing efficiencies of more than one hundred per cent.

The many serious accidents from explosions of steam pipes suggests the use of a number of moderate-sized mains rather than one

or two very large ones. Among awkward accidents arising from want of foresight in design may be cited a case where a large valve in a steam main was shut down while some changes were made in pipe connections; when the time came to again start up the machines on the other side of this valve, it was found impossible to do so, owing to the pressure upon the valve itself. After applying force till it was feared that the valve might be broken by greater strain, a spare boiler had to be fired up in order to equalize the pressure on both sides of the valve, and allow of its being opened. The consequence of not having a by-pass around that particular valve had been overlooked, as it had originally been placed in the line for use only in case of extension.

Those who travel on an ocean steamer often wonder at the perfection of engines which run for days and weeks together without a stop. The marine engine, however, generally gets a pretty thorough examination and a partial overhauling at the end of every trip, and in an emergency can always be slowed down or stopped for a few minutes or hours; the engine in the power-house, however, must go on; slowing is as bad as a stop. Moreover, the time for repairs is generally very short; as many as possible spare interchangeable parts must be in readiness for needed substitution. No care is too great to give the engine while in operation.

There are fashions in engineering as well as in dress, and both move in cycles. The earlier electric-light stations generally consisted of small dynamos driven by independent high-speed engines; when the reaction set in against these on the score of economy, large engines driving through shafting and countershafting became popular. The increased trouble due to belting, and the evolution of larger and larger dynamos, turned design into the original channel of direct-belted units. With the power dynamo came the new difficulty of constant and heavy changes in load, until in many cases the duty of a power-house engine became a compound of steamship and rolling mill. The only radical cure lay in direct coupling, coming back after all to the direct-driven steam dynamo, the type installed in the first large station built,—that of the Edison Company in New York.

It used to be that the dynamos were the most delicate, the least understood, generally the most tricky, and the most exacting things in a station. This was very largely due to poor mechanical design and inferior work. Now the dynamos require as little attention as anything about the plant. To keep them clean and dry and their bearings oiled is all that is needed; when anything does go wrong, however, there is a deal of trouble. The worst troubles to deal with in a dynamo are those which occur deep in the interior; many can-

not be observed except when work is being done. The cultivation of a habit of close observation is, therefore, valuable, but it is difficult to impress upon men that things which in themselves are so slight as hardly to be seen may be the symptoms of a serious disorder.

A new danger has been introduced with the advent of electric transmission—the enormous amount of power which may be concentrated and let loose at a point apparently safe. In a boiler or engine room the presence of the machinery naturally gives the impression of a large force close at hand, but a copper rod, perfectly quiet and harmless-looking, gives no idea of the terrible destruction it can work.

It is the necessity for continuous service at all costs which brings the greatest strain upon the superintendent. Boilers may leak, valves may break, engines may knock, journals may heat, but the plant must go on. He has to consider, on the one hand, his duty to the public, who will suffer great inconvenience and loss if he shuts down, while, on the other hand, he may be endangering the lives of his employees. Of course, the matter is simplified if the failure of lights or power would endanger the public, since there can be no choice between risking the lives of many and helpless people and those of a few skilled men knowing their danger and able to take all possible precautions. Fortunately the dilemma occurs less and less frequently, its very seriousness having early attracted attention to it; but it comes often enough in one shape or another to form a decided factor in nervous strain.

ISOLATED PLANTS VERSUS CENTRAL STATIONS.

By Percival Robert Moses.

I.

THE attention of architects, engineers, and owners has been persistently directed to the question of comparative economy of a central-station supply for light and power and a similar supply from a private or so-called "isolated" plant in the building to be equipped. Articles pro and con have been published, containing conclusions based on theoretical conditions of amount of coal per horse power hour, cost of labor, water, oil, etc. I herewith present a comparison of the various items making up the total cost, as well as the final amounts, in installations with an isolated plant, and the corresponding items and totals in buildings obtaining their supply from central stations. The data have been obtained from the superintendents, engineers, and—in many cases—owners of the buildings, and I think they may be relied upon absolutely. The names are withheld for obvious reasons. In most cases they may be obtained by anyone wishing to investigate the results.

The comparisons instituted, to be of value, must relate to buildings similar in character, size, and relative situation. For convenience in tabulating and reference the installations have been divided into groups.

First: hotels, where a continuous service in most of the departments is required.

Second: apartments, where the service is continuous in some branches and intermittent in others.

Third: office-buildings (generally with ten-hour service).

Fourth: restaurants, clubs, etc., where the service is special in character, and each case must be individualized.

Fifth: buildings where the service is intermittent, with large maximum and small average load.

These groups do not include all the varieties of buildings constructed, but the classes are sufficiently broad and distinct to enable an engineer, architect, or owner to place his proposed building in one of them, and thus obtain an approximate estimate of the operating cost of an isolated plant under ordinary working conditions, and also of the cost of a similar supply from the central station.

In collating these statistics, many other points of interest were brought out, such as the relative advantage of the different sizes of coal, the economies resulting from the use of gas engines, storage batteries, exhaust steam, etc., which can only be briefly mentioned here. For example, it was proved that small sizes of coal give better results, weight for weight, than the larger sizes, if burned in suitable furnaces; that gas engines show large economies where the heating of the building is a small factor; and that storage batteries offer inducements where the service fluctuates largely, and in small installations where low-pressure steam for heating, dryers, etc., is required during the day.

In the class of buildings first considered—hotels—the service is severe and continuous. Steam is necessary in large quantities, irrespective of the requirements of a lighting plant, for heating, steam-mangles, drying-rooms, auxiliary engines, pumps, elevators, and kitchen. A trained engine-room staff is necessary, and usually consists of a chief engineer, two assistants, and firemen. In the larger hotels steam fitters, plumbers, and brick and tile layers are also employed. The addition of a lighting plant renders advisable the employment of a dynamo tender. The fuel cost is but slightly increased by the summer illuminating requirements. Therefore the central station service cannot profitably compete in economy with the isolated plant. That numerous hotels continue to use the central-station service is a remarkable example of the conservatism of capital; specious arguments, uncertainty of tenure, and lack of definite figures have prevented the proprietors from fully realizing the enormous amounts wasted.

Referring to Table I,—hotels 1 and 2 are old hotels, similar in size and in character of business. In the first, broken coal is employed, the boilers carrying 80 pounds, pressure, used directly on the radiators without any reducing valve. In addition to the heating, steam is supplied to kitchen, laundry, two elevators (one hydraulic high-speed and one steam freight), a slow-speed 20-h. p. laundry engine, and pumps. The cost of coal averages $24.10 per day. There are two engineers, two firemen, and one oiler, and the cost of fuel (coal), oil, water, and labor is $13,000 per year. The bills for lighting (gas on all floors, except the ground floor, which has electric lights) aggregate $11,000 per year. In the parallel case, No. 2, pea coal is used, at about two-thirds the price of the furnace coal. Ice is made on the premises, and refrigeration supplied to the store-rooms. The hotel is lighted night and day, and steam is furnished to laundry, kitchens, etc., and to one hydraulic combination freight and passenger elevator. The cost of fuel, labor, and repairs is less than $10,500 per year.

In these two buildings the labor employed is equal in cost and

TABLE I.—GROUP i.

No.	Character Bilding	Dimensions. H.	W	L.	Stories.	Total Lights.	Load Average.	Fuel, cost per day	Est. c'st Light. Plant.	Elevators. E. S. H	Plant Operation, cost per year.	Ice Supply.	Average Tons.	Labor. Eng	Firemen	Others	Hours Service	Heating System.	Coal Used.	Total Annual Oper'g Cost.
1	Hotel	85	75	175	7	1300	200 (D) 700 (N)	24.10	——	1. 1.	(P) 13000.00 (L) 11000 00 (I) 2500.00	Company	2 (Est)	2	2	1	24	Direct High Pressure	Broken	26500 00
2	Hotel	80	125	125	6	1500	300 (D) 1000 (N)	16 50	4500	1	10500.00	Machine	2	2	2	1	24	Exhaust.	Buck-wheat	10500.00
3	Hotel	100	125	100	7	1200	200 (D) 700 (N)	10 00 (Est)	——	1.	(P) 6000 00 (L) 8000.00 (I) 3000.00	Company	2¾	2	1	—	24	Direct Low Pres.	Pea	17000 00
4	Hotel	85	100	100	7	1000	150 (D) 600 (N.	11.00	4000	1	7000 00 (I) 2200.00	Company	2 (Est)	2	1	—	24	Exhaust Live.	Buck-wheat	9500 00
5	Hotel	85	250	125	6	2000	400 (D. 1500 (N)	22.50	——	2.	(P) 13000 00 (L) 17000 00 (I) 4000 00	Company	4½	3	3	1	24	Direct Low Pres.	Furna'e Coal	34000 00
6	Hotel	100	250	125	7	3000	800 (D) 2000 (N)	27.00	8000	3.	18000.00	Machine	5	3	4	1	24	Exhaust.	Pea	18000.00
7	Hotel	100	250	200	7	3000	500 (D) 1700 (N)	25.00	9000	1. 5.	15000 00	Machine	2	3	3	2	24	Exhaust.	Buck-wheat	15000 00
8	Hotel	100	250	200	7	4000	1000 (D) 2500 (N)	34 25	17000	6.	20000.00	Machine	6	3	4	2	24	Exhaust.	Buck-wheat	20000 00
9	Hotel	85	75	100	6	800	—— (D) 600 (N)	12.00	2500	1.	5500.00 (I) —— ?	Company	—	2	—	—	12	Exhaust Live	Pea	5500 00 (I) – ?

TABLE II.—GROUP II.

No.	Character Building.	Dimensions. H.	W.	L.	Stories.	Total Lights.	Load Average.	Fuel, cost per day	Est'm'd cost Plant.	Elevators. E S H	Plant Operation, cost per year.	Ice Supply.	Items Included in Rent	Labor. Eng	Firemen	Others	Hours Service	Heating System.	Coal Used	Total Annual Oper'g Cost
1	Apartment House	85	100	100	7	800	—— (D) 500 N.	4 70	——	2.	(P) 3000.00 (L) 5000.00 (Est)	Company	Heat, Light, etc.	2	—	—	24	Direct Low Pres.	Furn'ce Coal	8000.00
2	"	85	100	100	7	850	—— (D) 600 (N)	4.60	2500	2.	3500.00	Company	Heat, Light, etc.	3	—	—	7	Exhaust	Pea	3500 00
3	"	85	100	100	7	950	—— (D) 500 (N)	4.50	2500	3	3400 00	Company	Heat, Light, etc.	2	1	—	7	Exhaust	Pea	3500.00
4	"	85	50	75	7	40 Halls only.	25 (D) 30 (N)	3.00	——	1.	(P) 2000.00 (L) 500.00	Company	Heat, etc.	2	—	—	24	Direct Low Pres	Nut	2500 00
5	"	85	50	100	7	500	—— (D) 400 (N)	2.75	2500	1.	(P) 3200.00 (L) 120.00	Company	Heat, Light, etc.	2	1	—	9	Exhaust	Pea	3500 00
6	"	85	60	100	7	700	—— (D) 500 (N)	2.50	3000	2.	2500.00	Company	Heat Light, etc.	2	—	—	8	Exhaust.	Buck-wheat	2500 00
7	"	85	80	150	7	1200	300 (D) 800 (N)	7.70	6000	2	6000.00	Company	Heat, Light, etc	2	2	—	18	Exhaust	Pea	6000.00
8	"	85	100	150	7	160 (Halls only.)	60 (D) 125 (N)	7 00	850	2.	4500.00	Company	Heat.	3	—	—	24	Live Exhaust.	Pea	4500 00
9	"	85	77	100	7 & 6	800	150 (D) 500 (N)	2.00	——	2.	(P) 2200 00 (L) 6600 00	Company	Heat, Light, etc.	1	2	—	18	Direct Low Pres.	Pea	9000 00
10	"	85	100	100	7 & 6	950	150 (D) 600 (N)	8.60	3500	1.	5500.00	Machine	Heat, Light, Refrigerator, etc.	3	—	—	18	Exhaust.	Buck-wheat	5500.00

number of hands; the fuel charge is smaller in the latter, notwithstanding the greater amount of work done. This is due primarily to the use of cheaper coal, the exhaust system of heating, and the utilization of the exhaust steam in numerous ways. By efficient engine-room management and the employment of an isolated plant,—notwithstanding its old style,—the heating, elevator-service, lighting, and refrigeration in the second case are obtained for less than the cost of the fuel and labor in the first. The central station and gas companies together charge $11,000 for lighting. The cost of the ice is more than $3,000 per year. These items constitute a needless waste, which must be charged to the profits of the business. The other similar cases—3 and 4 in Table 1—show the same causes and effects. In neither of the buildings (Nos. 2 and 4) having isolated plants are any extra book-keepers or superintendents engaged; in each case the exhaust steam, after passing through the heating system, is trapped back into the boiler without any ill effects, in apparent contradiction to the assertion made by Mr. R. S. Hale in THE ENGINEERING MAGAZINE for February, 1897, that such a proceeding is "impracticable." The depreciation on plants, such as those described, amounts to less than ten per cent., for in half a dozen similar buildings plants have been running eight or ten years and are apparently in good condition.

In each case the saving effected in one year was equal to the cost of installation, including in the cost of operation the interest and depreciation, and excluding the saving produced by the choice of fuel Numbers 5 and 6 in Table 1 represent very successful hotels. Their prices are moderate, and both cater to a transient class, although No. 6 has also a large residence patronage. No. 6 uses fifty per cent. more lights than No. 5; it has three elevators, instead of two, runs a laundry for two hotels, and makes its own ice. The plant is old-fashioned and much cramped; the boilers are old, as are also the elevators. Notwithstanding these conditions, the cost of running the plant of No. 6 is $16,000 a year less than the cost of running No. 5. One-eighth of this difference, $2,000, is accounted for by the use, in No. 5, of broken coal at $4.50 per ton, while No. 6 burns pea coal at $3.00. No. 5, having no lighting and refrigerating plant, uses live steam for heating and for laundry appliances.

The labor in No. 5 costs $100 a month less than that of No. 6. By not having a plant for lighting and refrigeration, hotel No. 5 has, therefore, saved $1,200 a year on labor. Deducting this from the $2,000 per year credited in hotel No. 6 to coal account, there still remains more than $15,000 a year, which can be due only to the difference in the cost of light and ice from the central supply as compared with the cost of manufacturing these products on the premises.

In No. 6 the excess chargeable to the labor account was $1,200 a year. The coal chargeable to the lighting account may be roughly assumed to be the difference in the actual number of tons burned in each case. The coal cost is, on this basis, $4,400 per year for the ice-making, refrigerating, and electric-lighting plant. The additional charges for water tax, oil, waste, and sundries for No. 6 do not exceed $200 a year; so that we can positively determine the cost of operating the electric-lighting and refrigerating portions of the plant to be less than $7,000 per year. This does not include depreciation charges, which average ten per cent. annually. No emergency supply (gas or electricity) from central stations is provided.

The lighting obtained from the central station and from the gas company costs, in hotel No. 5, more than $17,000, and the ice from $3,500 to $4,000 per year, making the total cost for light and refrigeration about $21,000 per year in this hotel, in contrast with the $7,000 per year for the isolated plant of hotel No. 6,—a saving of sixty-six per cent. In this case the saving that would be produced in hotel No. 5 by the installation of a plant for lighting and refrigerating would pay for the plant in eight months; it would pay for the complete installation, including wiring and fixtures, in less than fifteen months.

Hotel No. 8 is nearly double the size of No. 5. It has a lighting, heating, and refrigerating plant, and six elevators. The cost of operating and maintaining is $14,000 less per year than that of hotel No. 5. Hotel No. 5 is not an unusual case, and other hotels of like size will show similar results.

Next in order of consideration is Group II, comprising apartment-houses. In this class the question of economy of operation yields the position of prime importance to the question of the policy of including light and refrigeration in the rental charges. If the light is to be paid for by the tenants directly, the isolated plant should not be installed, irrespective of other economical conditions, as the tenants will, in time, demand free service. If the contrary is the case, it is invariably advisable to generate the current on the premises in houses containing more than ten apartments.

The usual method in New York apartment-houses is to give light "free" until twelve or one o'clock, after which the tenants pay directly for what they use. In many of these houses gas is used as fuel in the kitchen, and the slight increase in the gas bills for lighting is unnoticed. A number of the more modern apartments include refrigeration as well as illumination, heating, and elevator-service in the rent. The cost of operating a refrigerating plant is not large when the plant is used in connection with the rest of the service, and

the annoyance incident to the handling of ice is avoided; whether the rental returns are increased thereby is still a moot question. A large apartment-house is subject to the same problems as a hotel, except as to the kitchen requirements. The service must be continuous, but, tenants being fewer, it is less severe and costly. The departure in summer of from two-thirds to five-sixths of the tenants is an important factor in the yearly coal-consumption.

Table No. 2 contains statistics of ten houses selected from twenty as most fitted for purposes of comparison. The remainder show similar results.

In the table, the "average load" column shows the number of lights generally burning during the day (D) or night (N) during the winter months. The fuel includes coal, oil, and water. In the column "Plant Operation" "P" refers to operation of plant; "L" to cost of central light and power service. In column "Heating System" direct pressure means employment of live steam directly in radiators. Exhaust is self-explanatory, as are the other columns.

Starting the comparison with large apartment-houses about one hundred feet square and seven stories in height, and comparing apartment No. 1 with No. 2 (or No. 3) we find that the coal bills, averaged for the year, are practically the same, but the labor is increased by one man at $40 per month in No. 2. In No. 1 the heating is done directly by low-pressure steam; in No. 2 by exhaust steam (with additional live steam in very cold weather, perhaps a dozen times during the season). Nos. 1 and 2 have two hydraulic elevators each. No. 3 has three. No. 1 uses broken coal at $4.25 a ton; Nos. 2 and 3 use pea coal at $3.00. Deducting the actual number of tons of coal burned in No. 1 from the amount used in No. 2, to roughly determine the coal required for the operation of the lighting plant in No. 2, the annual difference is found to be 130 tons.

At $3 a ton, this amounts to $390 a year. The oil cost in the two plants is not noticeably different, and the number of lamps used is the same. The additional water-tax in No. 2 is $35 per year. The fuel cost is, therefore, $420 and the extra labor $480 per year, being an operating cost of $900 per year with an additional charge of $300 a year for depreciation and repairs, thus making a total of $1,200 a year as the cost of operating and maintaining such an electric plant in connection with the steam plant. The average lighting current in Nos. 2 and 3 is 250 amperes or 500 lights, and the average time of burning is five hours,—a total of 2,500 lamp-hours per day. The cost of this amount of current from the central station at one cent (list) per lamp-hour, and fifty per cent. discount, would be $12.50 per day, $380 a month, or $4,560 a year. The saving pro-

duced by the operation of these plants in Nos. 8 and 9 paid for them in less than a year in each case.

Apartment houses Nos. 4 and 5, Table II, offer a good basis for comparison of two smaller buildings. Each contains fourteen apartments and one hydraulic elevator, and maintains a continuous service. No. 5 has one hundred more lights than No. 4, and burns these a longer (average) time each day. Notwithstanding the use of a private lighting plant and the increased lighting requirements, the coal cost in No. 5 is less than the coal cost in No. 4. This difference—$7.50 a month—about pays for the extra oil, water, and waste used in No. 5.

The lighting of the halls and janitor's rooms of No. 4 is at the cost of the owner. The average per month during 1896 was more than $40, while for No. 5 (only a few lights during the day when the plant is not run) the average was less than $10. The labor costs $60 a month less in No. 4 than in No. 5. The repairs are all made by the engine-room staff in No. 5, and have not amounted to $25 in cash during the four years the plant has been in operation; so that factor is immaterial. The depreciation of the machinery averages less than ten per cent. on cost of plant, or $250 a year. This makes the total cost chargeable to the isolated plant of No. 5: labor, $720; fuel, $250; and depreciation, $250,—a total of $1,220 a year, from which must be deducted the extra hall-lighting cost of No. 4,—*viz.*, $360 a year, showing the actual extra cost imposed by the operation of a private electric plant in this case to be $860 a year. The cost of the lighting in this building, if supplied from the central station, would be more than $3,000 with the rates at ½ cent per lamp-hour during nine months, and ¾ cent during the three months in which half as many lamps would probably be lighted.

The difference in the cost of supplying light to buildings similar in size to Nos. 4 and No. 5, if supplied from a private plant instead of from a central station, would pay for the plant in a little more than one year.

A system combining the use of electric elevators, pumps, and lights operated from a central station, and low-pressure boilers for heating, has been strongly advocated. No. 9 has such a system, and No. 10, although larger, offers a good basis for comparison.

These houses are built in the best possible manner, and are fitted with all modern conveniences; the rents vary from $1,000 to $2,000. Each has twenty-eight suites, and maintains continuous service. No. 10 has, in addition, a refrigerating plant supplying all the ice-boxes throughout the building. The lighting requirements are also greater. Beside the house-lighting, (identical with that of No. 9) four large

stores and a large hall are lighted half the night and part of the day. No. 9 has two electric elevators. No. 10 has one hydraulic elevator. No. 9 uses low-pressure steam for heating. No. 10 heats entirely by exhaust, and all returns lead to the boiler. No. 9 employs two firemen all the year. No. 10 employs three engineers. No. 9 purchases its light and power (for two elevators and one pump) from an apartment-house near by. No. 10 has its own plant. No. 9 uses ¾ of a ton of pea coal per day. No. 10 uses 3½ tons of buckwheat coal per day. The wages paid in No. 9 are $70 a month less, and the fuel cost is $6.38 per day less, than in No. 10,—a difference of $3,140 per year. No. 9 pays, in addition, more than $550 a month for its light and power, the rates being the same as those of the Edison Illuminating Co. The ice is bought by the tenants. No. 10, therefore, obtains its heating, light, power, and refrigeration for $3,600 a year less than No. 9. This difference will more than pay for the plant required in one year. The large apartments show similar results.

THE MINERAL RESOURCES OF ARIZONA.

By Thomas Tonge.

THE area of Arizona (113,000 square miles) is exceeded in size in the United States only by California, Montana, Texas, New Mexico, and Alaska. Its area is larger than that of Connecticut, Delaware, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont combined. The United States land office credits the territory with 49,000,000 acres (more than 76,000 square miles) of rainless region, where crops cannot be produced. It is no wonder, therefore, that the eleventh United States census (1890) gives the population of Arizona at 59,620 (exclusive of Indians), which subsequent immigration, however, has nearly doubled.

By artificial irrigation nearly 2,000,000 acres have already been brought under cultivation in the territory, and additional irrigation enterprises are under way. Wherever irrigation is possible, the natural climate, giving perpetual sunshine and absence of snow and frost, affords twelve months of growing season, and phenomenal crops of cereals, forage plants, vegetables, and fruits. A man can spend one day at his mine, and the next day "under his own vine and fig tree."

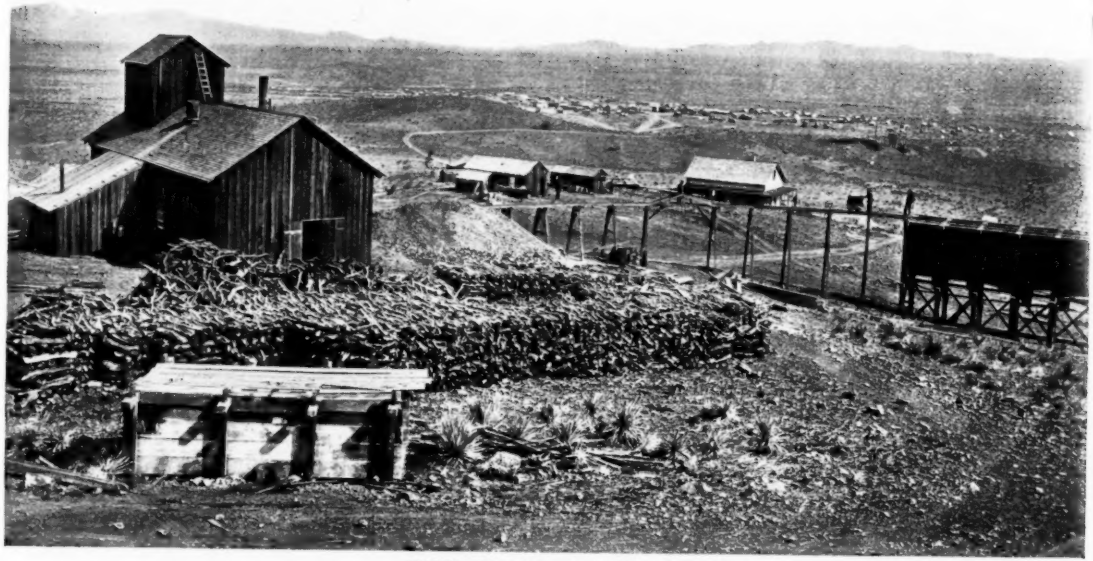
Arizona is rich in minerals,—gold, silver, copper, lead, iron, manganese, coal, etc.,—not less than 40,000,000 acres being classified as mineral-bearing. The total value of the output of gold, silver, and copper during the last twenty years was about $120,000,000.

The annual reports of the United States mint at Washington for the last four years credit Arizona as follows:

Year.	ounces, *gold.*	ounces, *silver.*	pounds, *copper.*	pounds, *lead.*
1893	58,911	2,594,131	44,251,283	3,285,992
1894	96,313	1,539,453	31,162,400	2,625,000
1895	93,580	1,170,193	29,930,046	1,790,149
1896	134,344	963,513	43,334,520	1,026,500

The chief region of metalliferous minerals and mines commences on the north-west, in Mojave county, at the sharp bend of the Colorado river at Callville, and extends south-eastward diagonally across the territory for nearly five hundred miles in a broad belt of high and rugged mountains, including the Bradshaw, the Mazatzals, the White, the Apache and Pinal, the Santa Catalina, the Santa Rita, the Huachucha, and the Chiracahua mountains. The chief towns, min-

BISBEE, COCHISE COUNTY, ARIZONA, SHOWING COPPER QUEEN MINES.



TOMBSTONE, COCHISE COUNTY, ARIZONA.

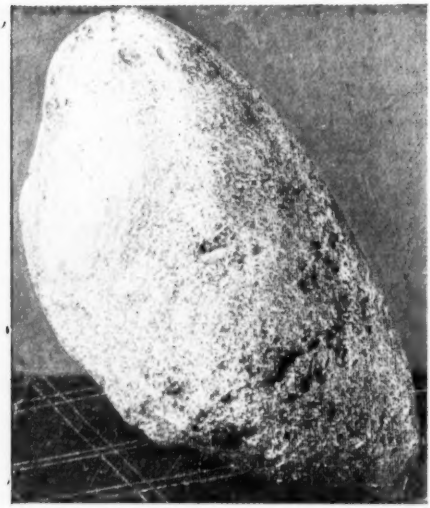
ing camps, and mining districts are found along or upon the margin of this broad central belt. Commencing at Callville on the Colorado river, we have in south-easterly succession Mineral Park, Hillside, Congress, Jerome, Prescott, Phoenix, Florence, Pinal, Globe, Mammoth, Tucson, Tombstone, Bisbee, Pearce, Arivaca, and Oro Blanco. The Longfellow copper mines and others, of Clifton, lie upon the north-eastern border of the belt, while upon the south-western border we find the celebrated districts of Harquahala, Weaver, Vulture, and many other districts. Passing further westward, we come upon the lava or Piedmontese region of broad and extensive valleys and plains, broken by numerous isolated ridges and ranges, all trending north-west and south-east, parallel with each other and with the main central axis of mountains. These mountain ranges and valleys fill out the area of the territory to the Colorado river on the west and Mexico on the south. They are all mineral-bearing.

The ancient district of Castle Dome, celebrated for its beautifully-formed veins of argentiferous lead ores, lies about twenty miles north of Yuma, in the extreme south-west of Arizona. Silver districts with very large veins carrying silver ore adjoin Castle Dome at the north, and there is a continuous series of mining camps and locations of gold, silver, and copper ores northward along the Colorado river to La Paz, Ehrenberg, Bill Williams Fork, Mojave, and beyond.

The territory is subdivided into twelve counties,—*viz.*, Apache, Cochise, Coconino, Gila, Graham, Maricopa, Mojave, Navajo, Pima, Pinal, Yavapai, and Yuma. Apache and Navajo have not as yet developed mineral resources to any appreciable extent.

Cochise county (population, 6,500; area, 6,792 square miles) is traversed by the Southern Pacific railroad and the New Mexico & Arizona railroad, and is one of the leading mining counties of the territory.

Bisbee is one of the most prosperous districts in Arizona, and is purely a copper producer, the largest properties being owned by New York capitalists under the name of the Copper Queen Mining Company. The company runs four blast furnaces, smelting about four hundred tons of ore per twenty-four hours, the product being matte, which in turn is "bessemerized," or treated by the pneumatic method in two stands of trough converters of what is known as the Copper Queen or Williams type. The converters give a product assaying 99.2 per cent. fine copper, which is shipped as fast as made. For the year ending June 30, 1896, 10,492 tons, or 20,984,510 pounds, of bessemer pig copper, averaging 99.2 per cent. fine, was produced, which amount will be exceeded in the year ending June 30, 1897. About eight hundred men are employed in the mines and at the smelting works.



SILVER NUGGET FROM ARIZONA, 31 POUNDS 900. FINE.

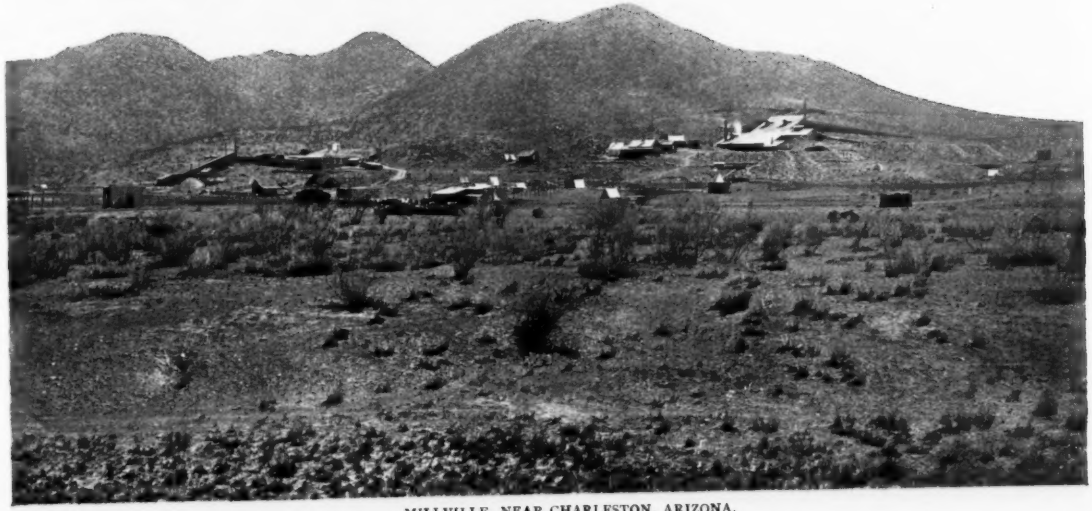
Tombstone, on the west side of the Dragoon mountains, is a purely silver and gold district —mostly silver. Once having a population of 12,000 people, it has now little more than 1,000 inhabitants, in consequence of the fall in the price of silver and the closing down of the silver mines. The mines are still there, however, and, if silver ever advances to anything like former prices, there will be correspondingly renewed activity in the locality. At present there are about one hundred men "chloriding,"—*i. e.*, taking leases of mines or portions of mines, subject to royalties varying with the value of the ore, and taking out such of the silver ore as is rich enough to ship to the smelter, leaving the lower-grade ore either in the mines or on the dumps. Probably the largest local company is the Tombstone Mining and Milling Company, representing New England and Philadelphia capital. This property has a past production record of several millions of dollars, but, at present, operations are suspended, and only about a dozen men are employed. Other local companies are the Contention

CONTENTION MILL, TOMBSTONE, ARIZONA.

GIRD'S MILL, CHARLESTON, ARIZONA.

CORBIN MILL, CHARLESTON, ARIZONA.

GIRD'S DAM, CHARLESTON, COCHISE COUNTY, ARIZONA.



MILLVILLE, NEAR CHARLESTON, ARIZONA.

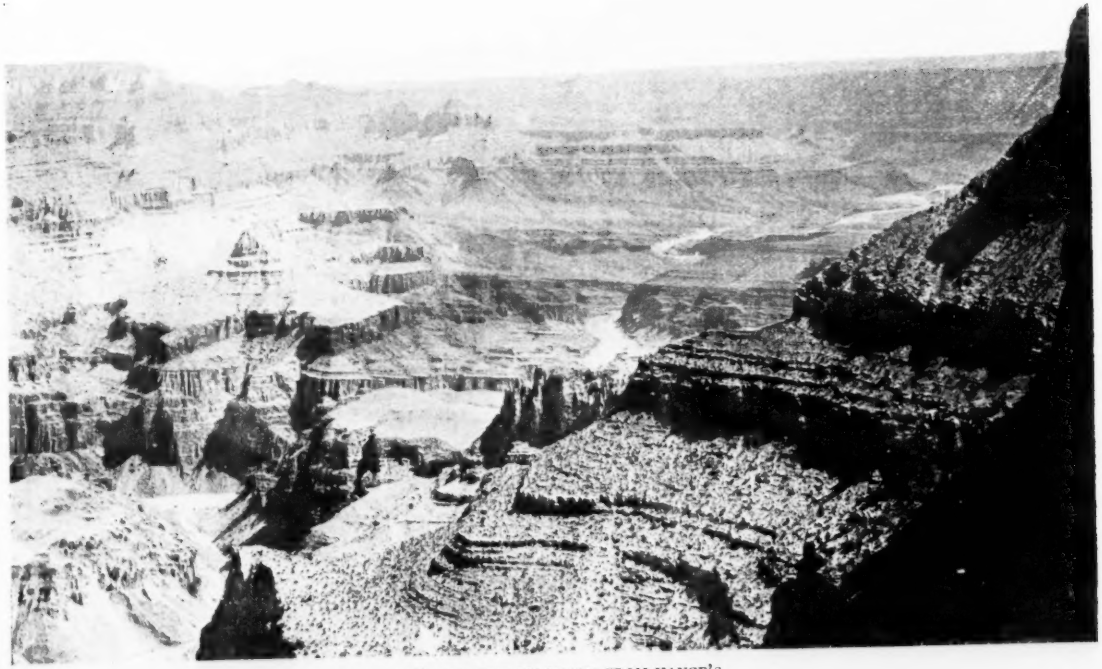
Company, representing San Francisco capital; the Grand Central Company, representing eastern capital; and the Empire Company, representing New England capital.

Pearce, about twenty-five miles east of Tombstone, on the eastern slope of the Dragoon mountains, has in about two years developed into a promising producer, although not much development work has yet been done. Rich ore was found in one place at grass roots. The leading property is the Commonwealth Mine, belonging to the Commonwealth Mining and Milling Company, capitalized at $2,000,000, mostly Philadelphia capital. On this property there is a 300-foot shaft, and about 2,700 feet of levels. This mine has large bodies of rich ore which has to be hauled fifteen miles to the nearest railroad point, Cochise, on the Southern Pacific railroad, and is thence shipped at the rate of several cars per day, over one thousand miles, to the smelters at Pueblo, Colorado, the railroad frieght alone being $11.75 per ton. The veins are large, and the croppings extend for more than half a mile. Professor R. A. F. Penrose (who occupies the chair of economic geology of the University of Chicago, and who, with Dr. Whitman Cross, prepared *The Pike's Peak Folio* and *The Geology and Mining Industries of the Cripple Creek District* issued by the United States geological survey) is president of this company. Professor William P. Blake, director of the Arizona School of Mines, says of this mine: "It is another example of the great amount of mineral wealth lying dormant, awaiting the prospector and the aid of capital. The croppings have been known for years, but, being in the low valley land and conveniently under foot and crossed by trails, they were disregarded and neglected until assays revealed the importance of the ore."

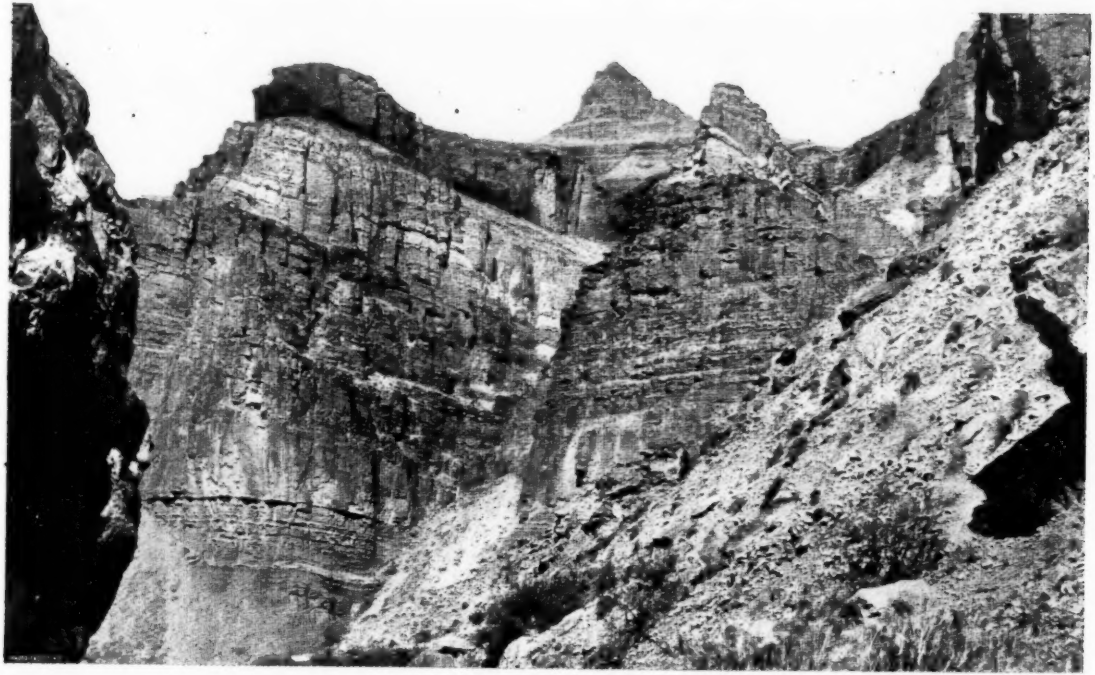
Coconino county (population about 5,000) is traversed by the Atlantic & Pacific railroad, and by the Grand Cañon of the Colorado. It has extensive deposits of coal, as yet only partially developed, and quarries of superior red sandstone. The nine-story Brown Palace Hotel, Denver, was built of this stone, hauled nearly one thousand miles by railroad. The Grand Cañon of the Colorado merits special mention. The Colorado river is formed in southern Utah by the confluence of the Green river and the Grand river, and flows southward until it reaches the Gulf of California, two thousand miles from its principal source. It drains a territory of 300,000 square miles. For hundreds of miles it flows through an appalling fissure at the foot of stupendous cliff terraces, down which descent can be made only at intervals of many miles, and then usually with considerable danger. No photograph will ever give a sense of the immensity of this wonderful phenomenon, and the most stupendous portions of the cañon afford no

SCENE IN THE GRAND CAÑON OF THE COLORADO.

HOVEY'S POINT, CAÑON OF THE COLORADO.



CAÑON OF THE COLORADO FROM HANGE'S.



SCENE IN THE GRAND CAÑON OF THE COLORADO.

BRIDGE OVER CAÑON DIABLO, ATLANTIC & PACIFIC RAILROAD.

coign of vantage for the effective utilization of the camera. What is known to geologists as the Grand Cañon district is mostly in Coconino county, the total vertical depth of the chasm being more than a mile. Recently much attention has been attracted by the mineral discoveries along the Grand Cañon, which include gypsum, asbestos, gold, silver, lead, and extensive and remarkable strikes in copper. The claims already located are said to show unusually wide and extensive deposits in limestone, the ores being chiefly carbonates and oxids, the assays running unusually high. The deposits were first encountered on the crest of the cañon, fifty miles north of Flagstaff, where the Anita Copper Consolidated Company has made the most extensive developments in the district. From this point, it is said, copper can be traced in the development work, as well as by the outcroppings for fifteen miles to the cañon, and from the brink to a depth of nearly six thousand feet into the cañon itself, where the ore deposits are permanent in all the stratified formations of limestone, sandstone, and slate, clear into the archaic granite.

Another account says that the outcroppings of the veins are plainly visible on the faces of the precipitous cliffs. Not along ago a prospector obtained specimens which ran from twenty to thirty per cent. in copper. The cliffs are very steep, and the operators are building trails down their face to reach the veins which show below. In one place they have made a trail three feet wide at a point where the precipice is nearly eight hundred feet high, and are building a station on the vein. They will follow the vein about one hundred feet in from the face of the cliff, and then upraise to the surface, as they believe the vein goes much nearer the surface than the point where it shows. They will store the ore in stations, dumping the waste into the cañon, and, when they reach the surface, will widen the trail, and build a tramway to raise the ore. At some points in the cañon it is possible to build a road near the bottom, having an outlet six or eight miles down the river. Eventually this road will be built, and then all the ore will be lowered from the mines in the face of the cliff to the road at the bottom of the cañon. It is said that the ore is rich enough to warrant these expensive methods.

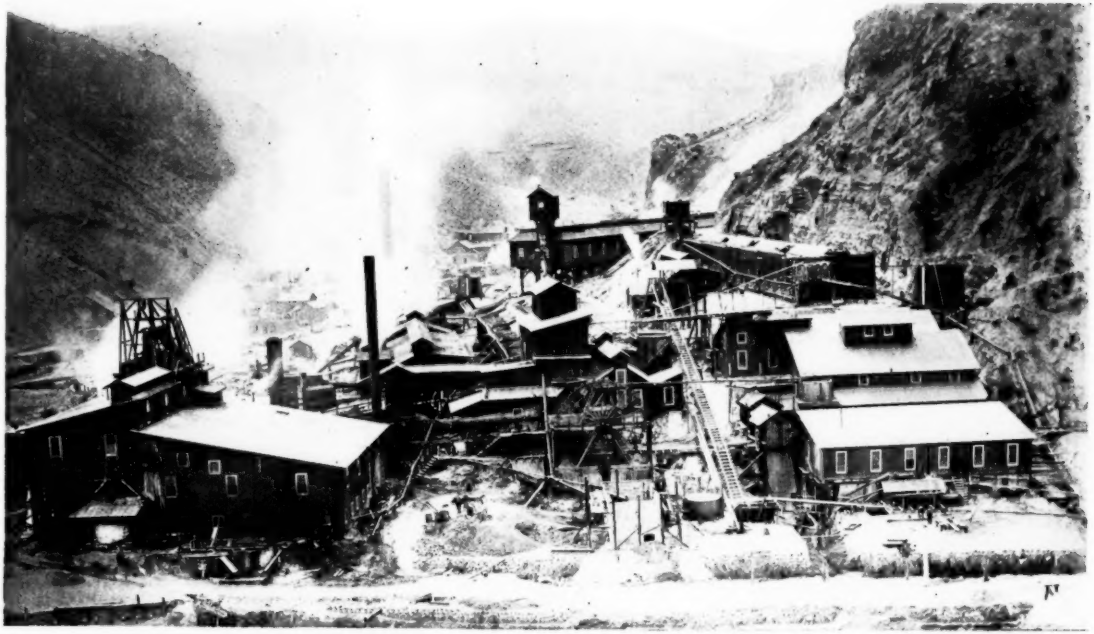
Gila county (population, 3,500) lies in East Central Arizona, and is the most inaccessible portion of the territory, as it is the only county which has no railroad communications; consequently its development has been retarded. Yet its principal and most important industry is mining, the Globe mining district taking the lead. One single mine—that of the Old Dominion Copper Company (representing Boston and Baltimore capital)—has a record of 70,000,000 pounds of ingot copper, direct at the furnace, 98.5 fine, valued at more than $7,000,000.

The United Globe Copper Company, representing New York capital, is now a heavy producer. The northern portion of the county, near Payson, is rich in gold, there being several stamp mills in operation. The most noted gold producer is the Kasser Gold Mining Company at Lost Gulch, eight miles from Globe. The ore is partly free milling, the concentrates averaging $16 per ton. The production has been at times $16,000 per month.

A district about thirteen miles from the town of Globe was formerly a great silver producer, the silver being found in pockets (usually small, but wonderfully rich) as a chlorid mixed with huge masses of native silver and invariably free from gold. These local mines usually contained from three to seven of these pockets, but in one case only one such pocket was found, which, however, netted the owners $168,000. With the advent of railroad communication, which cannot long be delayed, this county has an undoubtedly great future, as mineral is found more or less from one end to the other.

Graham county (population 9,000; area, 7,000 square miles) is tapped by two branches from the Southern Pacific railroad. The principal mining industry is carried on at Clifton and Morenci. The works of the Arizona Copper Company, Limited, are on the San Francisco river at Clifton, and the mines are from four to nine miles distant. An elaborate system of tramways and gravity inclines connects the mines with the works, several locomotives being constantly employed in feeding the plant with ores and transporting the coke, merchandise, and copper of the Company, as well as those of the Detroit Copper Company, hereafter mentioned. One of these copper mines—the Longfellow—has been a steady producer for nearly twenty years. The more profitable ores occur in a lime and porphyry contact. The Arizona Copper Company employs about 750 men, and annually pays more than $400,000 in wages and $12,000 in taxes—about one-fifth of the entire taxes of the county. The Arizona and New Mexico railroad belongs to this company, and runs from Clifton to Lordsburg on the Southern Pacific railroad,—a distance of 71 miles. It is a narrow-gage road, used exclusively in the work of the copper camp. The undoubted richness of the mines has justified the construction of the railroad by the mine owners. By this railroad a special grade of coal is obtained from Cerillos, N. M., from which gas is made in a special apparatus (manufactured in Glasgow) at a much less cost than that of any other fuel obtainable for power purposes. This company, representing Scotch capital only, has invested—with satisfactory results—in the mines, smelting plant, and railroad, $3,500,000.

The Detroit Copper Company, whose mines have been steady producers for more than ten years, has four large blast furnaces and a



SMELTER OF THE ARIZONA COPPER CO., LIMITED, CLIFTON, ARIZONA.

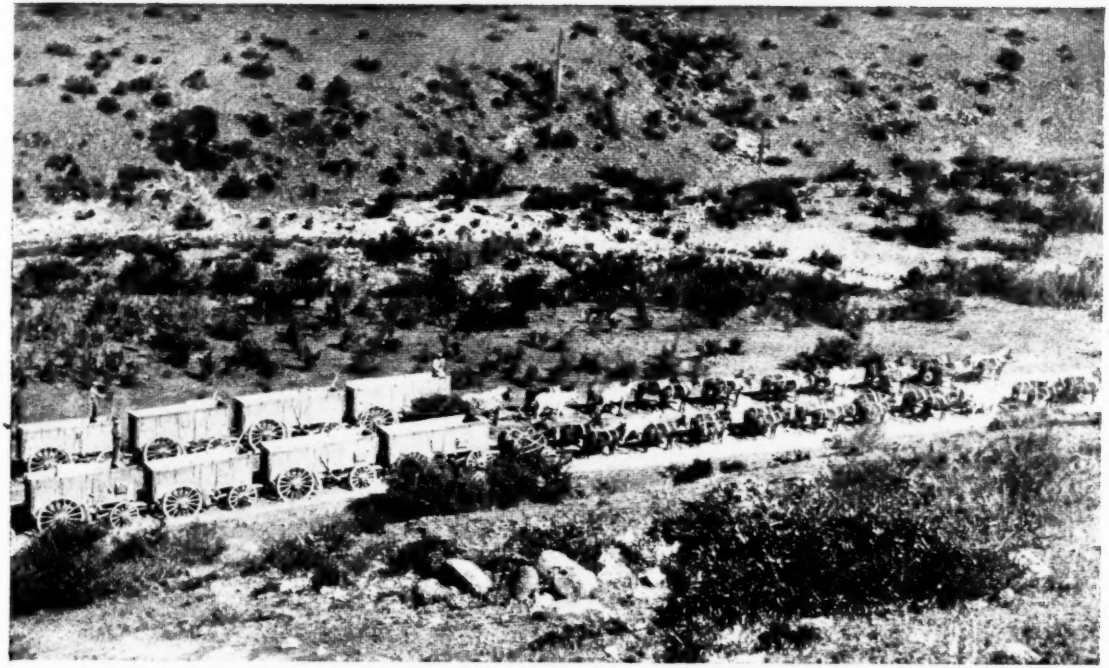
concentrating mill at Morenci, with water-supply pumped from the Gila river, seven miles away. This company also utilizes the Arizona & New Mexico railroad above described. It represents nearly $3,000,000 of Michigan and Colorado capital.

The mountains of Maricopa county (population, 3,100; area, 7,300 square miles) show surface indications of gold, silver, and copper. Until recently there has been no scientific prospecting, but in various localities prospecting and development work are now going on, as well as placer mining, the difficulties in the way being want of transportation and scarcity of water. A number of stamp mills are in operation.

Mojave county (population, 2,200; area, 12,000 square miles) is traversed by the Atlantic & Pacific railroad. The leading mining district is White Hills (fifty miles from the railroad), whose silver-bearing veins, discovered in 1892, have since produced 1,250,000 ounces of silver, besides gold. Of English capital $1,000,000 has been invested in this particular district since June, 1896. There is also an undeveloped gold-bearing region between White Hills and the Colorado river whose ores are not rich enough to justify the expense of a fifty-mile wagon haul and a thousand-mile rail haul to the Smelters in Colorado. There are, also, in various parts of this county, companies and individuals operating gold and silver properties and placers, a number of such silver properties being leased by "chloriders" on royalties.

Pima county (population, 12,000), traversed by three branches of the Southern Pacific railroad, has in operation about one hundred and fifty mines, large and small, producing gold, silver, copper, and lead; more than a dozen mills (none, however, exceeding twenty stamps); and three smelting plants,—one at Tucson, for copper, one at Rosemont, for copper, and one at Nogales, for lead. The Oro Blanco district (100 square miles), in the south-western portion of the county, owes its name to the fact that most of the placer gold is so largely alloyed with silver that the yellow color of the metal is lost, the gold being nearly white. This district has been less developed by workings below the surface than any other mining section in the country.

Pinal county (population, 5,000; area, 5,368 square miles), traversed by the Southern Pacific railroad, has silver mines of too low grade to admit of extensive operations at the present low price of silver. The Silver King mine, owned by California capitalists, is an exception, and is said to have paid $2,000,000 in dividends. It was closed down for some years on the exhaustion of its bonanza deposits, but was reopened last year on the discovery of further deposits of more



ORE TEAMS, PINAL COUNTY, ARIZONA.

YUMA, ARIZONA, SHOWING BRIDGE OVER THE COLORADO RIVER.

ORE ROASTS OF THE UNITED VERDE COPPER CO., JEROME, ARIZONA.

moderate value. The Reymert is another large silver mine. The Mohawk mine is a considerable producer of free-milling gold ore, the veins averaging twelve feet in width. In the county there are nine stamp mills, aggregating two hundred and five stamps.

SMELTERS OF THE UNITED VERDE COPPER CO., JEROME, ARIZONA.

Yavapai county (population 17,020), area 29,236 sq. m., traversed by the Atlantic & Pacific railroad and the Santa Fe, Prescott & Phoenix railroad (the latter connecting the Atlantic & Pacific railroad and the Southern Pacific railroad), has twenty-eight stamp mills in operation, ranging from five to forty stamps each, with a total of three hundred and fifty stamps. This county was, in 1895, the greatest producer in the territory, with $1,258,831 in gold and 322,033 ounces of silver.

The United Verde Mine Copper Company is a New York corporation controlled by Mr. W. A. Clark, of Butte City, Montana. The mine at Jerome furnishes employment to several hundred men. It contains immense bodies of copper ore, carrying also gold and silver. The veins occur in limestone in proximity to irruptive rocks. This mine is believed to net its owners not less than $100,000 per month. The Congress mine and its reduction works, consisting of a 40-stamp mill, cyanid plant, &c., (owned by Arizona and Chicago capitalists) employs three hundred and fifty men. Some time ago this mine was producing at the rate of about 3,600 ounces of gold per month, all from one vein, and, with the opening of a new vein and an increase of the milling capacity, it was expected to double its gold production. The Hillside mine is said to have produced $200,000 in gold and $180,000 in silver. In the Bradshaw mountains the Crowned King mine is the leading gold producer, and the Del Paco in the same district is said to have produced $250,000 in gold. Of the silver mines the Silver Belt has produced $600,000 in silver, the Dos Oris $600,000, and the Peck $3.000,000.

Several hundred men work on placers in this county. They average fully two dollars per day when at work, exclusive of the men who are employed by large companies, of which there are several, utilizing costly hydraulic plants. It is said that $500,000 worth of placer gold was taken from one acre in the Rich Hill district; that a solid $600 gold nugget was picked up on the surface of the ground, and is now in the possession of the Bank of Arizona; and that $120,000 in placer gold was taken from the Walnut Grove district.

Yuma county (population, 3,020; area, 10,138 square miles) is larger than Connecticut, Rhode Island, and Delaware combined. It is traversed by the Southern Pacific railroad. It contains an extensive mineral-bearing belt, as yet comparatively undeveloped and to a large extent not even thoroughly prospected. The most important mine, the Fortuna, owned by California capitalists, competes with the Congress mine in Yavapai county and the Commonwealth mine in Cochise county for the distinction of being the leading gold producer in Arizona, though only a year old. The Fortuna mine and mill are situated thirty miles south-east of Yuma City in a rainless region. Water is pumped twelve miles from the Gila river, through

CEREUS GIGANTICUS, A NATIVE OF THE ARIZONA DESERT, SOMETIMES ATTAINS A HEIGHT OF 60 FEET AND A DIAMETER OF 2 FEET.

a four-inch pipe, overcoming an elevation of 750 feet. The ledge is twenty feet wide, and, so far as opened, continues with depth. In four months 6,300 tons of gold-bearing ore were extracted, producing $220,500. Within less than 2,000 feet from the Fortuna vein are four other distinct, well-defined gold-bearing ledges, one ten inches wide, one two feet wide, one four feet wide, and one averaging twelve feet wide. The ore assays $20, $25, $8 and $12 per ton. Work is proceeding on these ledges. The Haquahala mine (belonging to English capitalists) is utilizing the cyanid process for the treatment of its tailings.

Summing up the mining situation in Arizona, it can be said that, owing principally to its supposed remoteness, the great mineral resources of this territory have not as yet received that attention from outside capital which they fully justify, although nearly all the great mining enterprises so far have been developed by outside capital. The material modification in March last of the anti-alien law affecting the territories will inevitably result in considerable additional investment of European capital. In a number of cases, at least, the necessary water-supply can be obtained by a judicious expenditure of a moderate amount of capital, which expenditure will be fully justified by the richness of the mineral deposits. In other cases the mining properties are of such extent and value as to justify the connection, with the trunk lines, of private branch railroads, thereby reducing the cost of fuel, supplies, ore freights, etc., as has been already done by the Arizona Copper Company. All the conditions of latitude, climate, and weather in Arizona are favorable to continuous mining and shipping the year round. Practically any mine in Arizona can be reached in less than fourteen days from London, the Atchison, Topeka & Santa Fe railroad, and its continuation, the Atlantic & Pacific railroad, being the favorite route from Chicago and the east to southern and middle California. This route has quick through trains, with the finest Pullman and dining-car service and the best-managed eating stations in the United States.

The one great need of Arizona to-day is capital in the hands of practical and enterprising men. This its vast mineral wealth and mining possibilities will certainly attract. With a judicious expenditure, the annnal output in gold, silver, copper, and lead is capable of indefinite expansion, to say nothing of the known deposits of iron, manganese, coal, and other minerals,—onyx, building stone, etc.,—which will eventually be developed and utilized.

THE ELECTRIC PLANT OF THE MODERN TALL BUILDING.

By Frank A. Pattison.

THERE are several factors which determine the success or failure of a tall building, but none play a more important part than the elevators, light, heat, and ventilation. Not many years ago each and every plant installed for these purposes was an experiment, but to-day plants are installed which produce predetermined results with surety. The four requisites specified can now be successfully supplied by the electric plant.

The electric equipment of a building is a plant, the finished product of which is light, heat, or power, made from the raw materials, coal and water. The plan by which an owner can get the best products cheapest and at the same time secure safety for life and property is the one to be adopted. The isolated plant is a factory where electric current is produced on a small scale, and the question whether it is cheaper for an owner to do his own manufacturing, or purchase from the central station, is one to be solved in each case, as like conditions never exist in any two cases.

The first portion of the plant to be considered is the boiler. The water-tube boiler has very wisely been almost universally chosen for installation in large office-buildings. This boiler gives greatest efficiency with greatest security. The shell boiler is not fit for such service. The choice between the return tubular and the water tube is usually prompted by the fact that the latter will give greater power in a given space, and is less disastrous in case of an explosion. A poor fireman makes boiler efficiency an impossibility. It is very difficult to obtain results coinciding with theory; it is sometimes done in single or test runs, but it is a very rare exception to find a boiler plant running regularly with the best possible efficiency. If this is so in large installations, how much more is it true of the boiler plants of the size usually found in office-buildings! The situation of the boilers is determined by municipal and other regulations, so that it is necessary to group the steam-consuming machinery with reference to the boilers. The boiler pressure used to be limited to sixty or eighty pounds, but during the last year several plants have been installed for one hundred and twenty-five to one hundred and fifty pounds, and have made an excellent showing. Time will increase rather than diminish this, as greater economy is being asked for with each new

installation. It is always best to use the steam as soon as possible after it leaves the boiler, and the engines should be placed accordingly. This has been too often neglected in the past. The number and size of boilers are too often determined by the available space; they should be determined by calculating the most efficient combination for the work in hand. The cost of property has compelled vertical rather than lateral extension, so that in future installations more boiler capacity must be designed and arranged to go in the same floor space.

The foundations for boilers and all machinery require very careful study. Piles should never be used, unless it is positively known that they will always be submerged. In some soils it has proved necessary to float the foundations on grillage beams. It is necessary to take especial care to insulate from the grillage, pier, and column work of the building. This is often effected by sand, held in place by brick walls. Heavy felt is sometimes employed. The most satisfactory foundations for a number of units of rapidly-moving machinery has been found to be a single large mass of concrete or masonry. This practice has been followed in a number of plants in Chicago, Buffalo, Philadelphia, and New York. One of the most massive constructions of this kind is found in the American Surety Building on Broadway. It is sometimes best to set the boilers in a caisson sunk to the first substantial stratum. There should be no vibration; if there is the least, it must be absolutely contained within the foundation, and not allowed to enter the structure. For this reason proper supports for steam piping should rest on the floor, or on small foundations, rather than on the steel structure.

The steam piping for engines has not received the careful consideration it should. This portion of the installation is now beginning to develop. The greatest care should be taken to deliver the steam to the cylinders perfectly dry. Expansion and contraction of pipes are to be amply allowed for, and vibration and noise must be prevented. This should be done by removing the cause, not by chasing it from one place to another. Noise may be heard in the upper stories and not below, and will increase rather than diminish.

Given dry steam and a solid foundation, the engine and dynamo in combination become the vital factors in the daily operation of the building. We say combination, because the use of direct-connected machinery has become universal for such work as we are speaking of. This combination is the source of the electric current which moves the elevators, lights the building, propels the ventilating apparatus, and furnishes the exhaust steam whereby the heating is done. Experience has shown that the generating plant should be divided into three or, at most, four units. Occasionally special circumstances vary this.

The size and number of units should be decided upon only after careful study of an accurately-plotted load line. A reduction of the load to as few cylinders as possible is certainly to be sought for. Every cylinder in use should be working with its most efficient load. Upon the result of these calculations also depends the selection of high- or low-speed machinery. It has been general practice up to date to have simple high-speed engines. Problems and conditions are now offering themselves that may in the near future change this. Regardless of the type of engine used, the multipolar dynamo forms the electrical portion of this transformer. These elements should be placed on solid cast-iron sub-bases filled with concrete or sand. These sub-bases are made either in one or two pieces. Some engineers prefer to have all units above fifty kilowatts have a sub-base in two pieces, with the adjoining faces planed and securely bolted. This method of construction has been thoroughly tested, and found trustworthy as to alignment. It is often difficult to get a large casting without a warp or some internal stresses that may be detrimental. The dynamo and engine must run without noise or vibration, and it should be possible to run them without any holding-down bolts, although they should not be so run, except for a test. The engine is usually made with an extended shaft, the extension being occupied by the dynamo armature. Many advocate a divided shaft with a solid or flexible coupling, but, as neither engine or dynamo is of use alone, and the precautions against sudden overload are so refined, it seems unnecessary to take this step. There can be no question of alignment with a properly-constructed foundation and sub-base. The self-oiling of all bearings is desirable, but is not yet universally demanded. It will not be long before all engineers will demand this. Indicator cards taken for friction load with and without self-oiling arrangement make a very interesting study, and will, in the end, create a universal demand on the part of engineers for self-oiling machinery. The possibilities of given pressure of steam in the known dimensions of the cylinder should be delicately weighed against the output of the dynamo to which it is to be attached, in order to have the two pieces of apparatus form a proper unit of power. The dynamo should be compound wound, unless special connection with other apparatus prohibits. It is now considered good practice to use a broad commutator and a number of carbon brushes. Up to the present year 110-volt dynamos for light, and 110 or 220 volts for power, have been used, but the advent and commercial success of the 220-volt lamp will give engineers wider scope for economy, and lead to the use of higher pressure without sacrificing the advantage of interchangeability always to be sought.

The most trying work the generating plant has to perform is the supply of current for running the elevators. The load will vary much, and between wide limits. This prohibits the running of lights and elevators from the same dynamo. A storage battery must be supplied to take the current not wanted by the elevators, or else the elevator generating units must be subdivided and placed upon the same shaft run by one engine, thus allowing the several elevators to equalize the load. The former plan is used in several large buildings in Chicago and New York. The latter is about to be tried in the New York Athletic Club, and, as the load is not sufficient, a lighting generator has been placed on the same shaft. Of course, the object to be attained is to keep the load line as straight as possible, and of such height as to insure economy in the cylinder of the engine.

The switchboard is a very important element in the electric plant of the modern tall building. Every wire from each dynamo should pass to its work through the switchboard. This must be equipped with proper instruments for showing the condition and work of each dynamo, and the necessary switches for the necessary sub-division and control of the various parts. This should be absolutely fire-proof in every part, and placed where there is proper circulation of air and careful protection from meddling and accident. It is too often tucked in some corner and given too little attention.

The storage battery has developed into an important part of the electric equipment of a building. It may perform one or several of the following functions: supply current to take care of the peak of the load; supply current for light during hours of light-burning; act as a balance spring between the power motors and bus-bars. Storage batteries are not needed in all large buildings, but the time is fast approaching when the designer of large isolated plants will have to give very careful consideration to this portion of the equipment. A great deal of the trouble of the past has been due to too small batteries, and that evil has not entirely disappeared. The line showing the duty required of the storage battery should be carefully plotted for each case, and the specification so drawn as to clearly show what work it will have to do. Too many batteries are installed without a very definite idea as to why or how much they are to do, or how long a time they are to be allowed to perform their work.

A storage battery should be installed in a room entirely shut off from everything else, and where good ventilation can be obtained. The cells must be so arranged that each can be carefully inspected and tested. If the cells are large, they should not be placed one above the other, unless absolutely necessary. The floor should be pitched slightly, so as to be drained at one or several points. The size of cells,

the question of end-cell or counter-cell regulation, the number of cells, and the method of charging, must be decided upon for each installation, as no general rule can be made. The switchboard containing the instruments and switches for regulation should be placed near to, or built as part of, the generating plant switchboard. Too great care cannot be taken to keep the fumes from the battery away from everything. They should have no outlet, except to the outer air.

In such a climate as that of New York, sufficient exhaust steam can be derived from the electric-plant engines to heat the building, except in extreme weather. The steam, after it has passed through the feed-water heater, is reduced in pressure and passed into the pipes of the heating system. The back pressure on the engines caused by using the exhaust for heating the feed water and the building should never exceed five pounds. As a matter of fact, it is the exception when it reaches five pounds.

The pumps for feeding the boilers, for raising water for the building to the tanks on the roof, and for lifting the drip water to the sewer are steam pumps. There is no reason why this work could not be done with electric pumps. They are economical and very easily controlled.

The tall-building craze has spread rapidly, and it will take years to work out the requirements in the various departments. The electric elevator for skyscrapers is still in the development period, although in many buildings it is an important element of the plant. At the present time it is not possible to define the practice of the day, because each new plant brings out new methods and new apparatus.

One subject should be touched upon which is of vital importance to all connected with the erection of a modern tall building, and especially to the owner,—namely, the spaces in which the machinery is placed, commonly called the engine room. This should be light, thoroughly ventilated, and constructed of such materials as may be easily kept clean. Thousands of dollars worth of machinery is often placed in little more than a hole, where it cannot possibly get proper attention, and where the heat partially disables the best of men. This space, of course, is limited by circumstances, but there is no reason why the walls and floors should not be of easily-cleaned material, why light should not be abundant, or why ventilation should not be perfect.

THE HISTORY, STATUS, AND POSSIBILITIES OF ACETYLENE.

By Henry Harrison Suplee.

THE interest developed in the past few years in the use of acetylene as an illuminating agent makes an account of the various investigations into its properties and use appropriate at the present time.

While the development of the commercial side of the subject has been most active in the United States, the scientific investigations and researches upon which our more exact knowledge is based are mainly due to the labors of the French chemists and physicists, notably to MM. Berthelot, Vieille, Moissan, Bullier, and others, and to the Swiss scientist, M. Raoul Pictet.

Acetylene was first discovered by the English chemist, Edmund Davy, and brought by him to the notice of the British Association in 1836.* By heating carbon and potassic carbonate, he obtained a black substance which, when treated with water, gave off a gas of the composition $C_2 H_2$, and which he called a "gaseous bicarburet of hydrogen." Berzelius, in the same year, found the black substance from which Davy had prepared his acetylene to be carbid of potassium. In 1839 Professor Torrey first noticed, in some copper pipes used in New York for conveying gas, the presence of a brownish deposit, which proved to be an acetylid of copper, and which was found to be violently explosive under the influence of shocks or of slight elevation of temperature. This revealed the presence of acetylene in ordinary illuminating gas in small proportions, varying from 0.06 to 1 per cent. Similar observations were made in Europe by Crova and by Boettger, the latter preparing the acetylid of copper by passing illuminating gas through a solution of protochlorid of copper. Quet applied the same test to the gas produced by the decomposition of alcohol by the electric spark, or by heat, and also found that, when the copper solution was replaced by one of silver, a fulminating acetylid of silver was formed.

Calcium carbid, $Ca C_2$, was first prepared by Wöhler, in 1862, by raising an alloy of calcium and zinc, mixed with carbon, to a welding heat; and he observed that the calcium carbid thus produced gave a reaction with water similar to that produced by Davy with carbid of

*Brit. Assoc. Rep. 1836. Pt. 2, p. 62.

potassium, acetylene gas being given off at ordinary temperatures. Wöhler announced his intention of continuing these researches, but his death brought the investigations to a stop.

Our most complete knowledge of the properties of acetylene and its compounds, however, is due to the eminent French chemist, Berthelot, whose researches may be found in the transactions of the French Academy and Chemical Society since 1855. Following out his special investigations in synthetic chemistry, he passed hydrogen through a globe in which an electric arc was maintained between two carbon points. The gas thus treated, being subsequently passed through an ammoniacal solution of copper, formed acetylid of copper, thus proving the direct synthetic formation of acetylene. This experiment, performed in 1866, has become famous as the first example of the direct synthesis of a hydrocarbon. Those who are interested in the wide range of possibilities in organic synthesis which the commercial production of acetylene may open can do no better than follow the researches of M. Berthelot; but, as we are here discussing the production of acetylene as an illuminant, we must leave the synthetic side of the subject.

For commercial purposes acetylene is produced by the reaction of water with certain metallic carbids, and it is to the production of these carbids, and especially calcium carbid, that attention is now directed. Davy, as we have already seen, produced carbid of potassium, and Wöhler carbid of calcium, while, in the course of his researches, Berthelot has also made carbid of sodium by first producing acetylid of sodium and then converting it into carbid by heat. A carbid of barium has been produced by Maquenne, by several laboratory methods, but the cost bars all these, except carbid of calcium, from commercial consideration as sources of acetylene.

The production of calcium carbid in the electric furnace is one of those developments that naturally comes with the progress of the art; and, with careful experimenters at work in Europe and America, it is not surprising that almost simultaneous accounts of its discovery should come from various countries. The electric furnace had been in use from the time of the first production of the electric arc by Sir Humphry Davy in 1802, but it was not until the advent of the modern dynamo that it became a commercial possibility. In 1879 Siemens made a powerful electric furnace, in which he repeated on a large scale the experiments of Davy, and in 1885 Cowles applied the furnace to the production of the alloys of aluminum from corundum. The well known electro-chemist, Dr. Borchers, conducted experiments for several years, in Germany, as a result of which he stated, in his treatise on electro-metallurgy, published in 1891, that "all

oxids may be reduced by the action of carbon heated electrically." In France, Moissan made many experiments with the electric furnace, and at the close of 1892 he presented to the French Academy a memorandum announcing the fusion of lime and its partial combination with the carbon electrodes to form carbid of calcium, followed early in 1894 by the presentation of specimens of pure crystallized carbid in quantity.

In August, 1894, Mr. T. L. Willson, of New York, took out a patent for the production of carbid of calcium by heating a mixture of lime and carbon in the electric furnace, as a result of experiments conducted by him since 1888. Mr. Willson's experiments were originally intended by him to reduce refractory metallic oxids in the electric furnace in a manner similar to that of Cowles and Heroult. The attempt to produce metallic calcium resulted in the production of a slag which, by its effervescence with water, was recognized as carbid of calcium, and, from a published letter from Lord Kelvin to Mr. Willson in October, 1892, it appears that the latter was then in possession of the process.

Subsequent modifications have been almost entirely in the details of the furnace and methods of handling, and at the present time carbid is being manufactured commercially at Niagara; at Froges, in France; at Neuhausen, in Switzerland; and experimentally in many other places.

Calcium carbid, the prime agent in the production of acetylene, is a hard, dense material of a brownish-black color, usually with a crystalline fracture, and a specific gravity of 2.22 to 2.26. Though quickly decomposed by water, it is otherwise a peculiarly inert substance, and in a dry atmosphere it is practically without odor. The ordinary moisture of the air decomposes the exterior surface slowly, evolving acetylene with its characteristic odor, and converting the exterior of the lumps with a coating of lime.

The rapidity of the reaction with water is in marked contrast with the carbid's indifference to other substances. A lump of carbid thrown into a vessel of water will at once cause a strong ebullition, the acetylene bubbling up through the water to the surface, where it may be ignited, burning with a luminous, smoky flame.

When this gas is collected in a suitable holder, and delivered to proper burners, it forms one of the most brilliant illuminating agents yet discovered. The light is without the glare of the arc lamp, or the reddish glow of the incandescent loop, and the flame, in color and temperature, is especially grateful to the eye.

Photometric tests have shown that, for equal volumes consumed, acetylene possesses about twelve times the illuminating power of the

best coal gas, burned in the ordinary burners, at the same time producing decidedly less heat.

These facts being known, it appeared that the commercial production of calcium carbid at a reasonable price had placed a most valuable illuminating agent within immediate grasp. A closed vessel containing carbid and provided with means for introducing water and drawing off the gas constituted a generator of unparalleled simplicity and convenience. Soon also it was found that the gas could be liquified, either by pressure or cooling, or both, thus making it available for portable uses, such as car-lighting and the like; in fact, the advantages of the gas seemed almost unlimited.

However, practical difficulties soon appeared in connection with the generation and use of the gas.

Corrosion in the metal fittings and connections, with the formation of metallic acetylids, became apparent. The generator often became highly heated, and the temperature did not always diminish upon the stoppage of the water, nor did the formation of gas cease. The burners became choked, and the illuminating power of the gas varied, and, altogether, the results of experience showed that much was yet to be learned about the generation and use of acetylene. Added to this came the fear of explosions; particularly with the liquefied gas, several dangerous and some fatal accidents occurred, rendering it evident that the new illuminant needed thorough investigation.

The very extensive experiments of MM. Pictet, Berthelot, and others, however, have resulted in so large an addition to our knowledge of the causes and remedies for these objectionable features that we may feel more and more assured that, with the exercise of ordinary care and intelligence, and the use of apparatus constructed in accordance with the knowledge thus acquired, acetylene will yet become a safe, successful, and economical illuminant.

In order to discover the conditions existing in connection with the generation of acetylene by the union of calcium carbid and water in a closed vessel, Pictet made a most thorough experimental investigation. Assuming the behavior of the materials to be altogether unknown, he prepared an apparatus consisting of a strong steel cylinder communicating with a steel coil closed at the end and submerged in water. In the cylinder he placed five kilograms of carbid, and bolted it close, having placed in it also a number of weighed wires of various metals, to observe the chemical action upon them. A powerful force-pump permitted the introduction of water against high pressure, and pressure gages and thermometers enabled the pressures and temperatures to be closely observed. The entire apparatus was tested under a

pressure of three hundred and fifty atmospheres, after which all the air was exhausted, so as to insure the presence only of the materials which it was intended to investigate.

A small quantity of water was first introduced, and the generation of acetylene commenced. During the first ten minutes the pressure steadily rose in exact proportion to the quantity of water supplied, after which it remained stationary at a value corresponding to that of liquefaction at the temperature of the water surrounding the coil. On the introduction of more water, the temperature rose rapidly, and in a quarter of an hour it had reached the boiling point. The pressure of liquefaction also began to rise, probably due to the generation of impurities which would not liquefy. Suddenly the pressure gages gave a jump to nearly three hundred atmospheres, and a violent shock jarred the ground. In an instant the entire gaseous contents of the generator and coil had become dissociated with explosive force. The hydrogen had been liberated, and the carbon deposited in the solid form, and the acetylene was no longer in existence. The strength of the apparatus had prevented any accident, but the force of the explosion was such as to give unmistakable demonstration of the violence with which, under certain conditions, acetylene will explode. Upon opening the cylinder, it was found to contain a coating of carbon, in an extremely fine state of subdivision, while the metallic wires showed various degrees of corrosion. A number of repetitions of this experiment gave substantially the same result, and proved that the generation of acetylene in closed vessels by adding water to calcium carbid may produce pressures and temperatures sufficiently high to cause disastrous explosions.

Having this knowledge, it is not difficult to avoid the occurrence of these conditions, and various arrangements of apparatus have been devised by Pictet and others to avoid the possibility of such dangers. Excessive pressure can be avoided by providing capacity for the maximum production, or by suitable safety-valve or relief chambers. Dangerous temperatures can be checked either, as suggested by Pictet, by using coils of pipe containing cold circulating brine from a refrigerating machine, or, more simply, by plunging the carbid into an excess of water to absorb the heat. Whatever modified details be adopted to secure these ends, it must be admitted, as a result of these experiments, that the adding of small quantities of water to comparatively large masses of carbid is not only unadvisable, but positively unsafe.

Apart from the results obtained by Pictet, the researches of Bullier, Vieille, Pintsch, and others have shown that even the moderate rise in temperature of the exterior of lumps of carbid is undesirable from the point of view of economy. The principal impurities found

in acetylene are ammonia, sulphuretted and phosphuretted hydrogen, nitrogen, and carbonic oxid. Of these the ammonia is very objectionable, because its presence greatly assists in the formation of the fulminating acetylids of copper, wherever the gas comes in contact with copper or copper alloys. The other impurities detract from the illuminating power, and add to the odor and to the toxicity, and these are much more readily formed when the carbid is hot than when it is kept at a moderate temperature. It is also found that the hydrated lime which is formed as a result of the decomposition of the carbid will absorb water when warm, which it again gives out on cooling, so that, while the generation of gas may have apparently ceased with the stoppage of the water-supply, it will recommence when the cooling lime gives up a portion of its moisture to the as yet undecomposed carbid. For these reasons those who have had much experience with the generation of acetylene prefer to plunge the carbid entirely beneath a comparatively large volume of water, generating the gas in a cool condition and preventing many uncertain and undesirable reactions. Pictet insists that this is the only safe method, and it certainly has much to recommend it.

When the gas is thus generated under water, the temperature will rise only a few degrees, if sufficient water be present. One pound of carbid evolves about nine hundred British thermal units while generating about 5½ cubic feet of acetylene, so that it would raise the temperature of six pounds of water from 62° F. to the boiling point; dropped into 100 pounds of water, or about 12 gallons, it would raise its temperature only 9 degrees. The presence of the water also serves to absorb nearly all of the ammonia, and much of the sulphuretted hydrogen, although, when saturated, it should, of course, be renewed. Acetylene generated in this manner may be still further purified, and the entrained moisture removed, by desiccating materials, after which it will no longer attack copper, or foul the tubes or burners, and will give uniformly its maximum illuminating effect.

Against such acetylene there is no reasonable objection on the score of danger. It is probably no more poisonous than ordinary illuminating gas, while its characteristic odor causes leaks to be readily detected. A number of experiments by Vieille and Berthelot have demonstrated that at atmospheric pressures a decomposition originated at any point is not propagated through the mass of the gas. Neither a spark, an explosion of fulminate, or direct contact with flame causes any action beyond the immediate vicinity of the heat. When, however, the gas is subjected to a pressure greater than two atmospheres, it exhibits all the properties of an explosive mixture; hence the danger line is clearly and definitely marked.

Mixtures of acetylene are, or are not, explosive, according to the proportions of the two components, the limits being between three of gas to one of air, up to twenty of gas to one of air, this being a somewhat wider range than is found with ordinary illuminating gas; with the care now taken against approaching leaks with lights, there is no greater danger.

The use of liquefied acetylene has been advocated for portable lighting, especially for railway carriages, and in many ways it is eminently adapted for such a purpose. In this form, however, even greater care is necessary, as it has been from ignorance of the properties of liquefied acetylene that the most disastrous casualties have occurred.

As we have already said, acetylene is readily liquefied by pressure and cold. The critical point, above which it cannot be liquefied by pressure, is 98.6° F.; at the freezing-point it requires 21.5 atmospheres, and at 67° F. 40 atmospheres, to reduce it to the liquid state. At a temperature of 62°F. the liquid is about 1-400th the volume of the gas, so that one cubic foot of the liquid acetylene will produce 400 feet of gas; hence the advantages for car-lighting appear at once. In order to use the liquefied gas, it is necessary only to provide the cylinder with a reducing valve to maintain a uniform pressure of two to four inches of water on the main leading to the burners. No other apparatus is required.

As the pressure due to the action of the gas is not excessive, there appeared no good reason to apprehend danger in using the liquefied gas in this manner, but the occurrence of fatal explosions in Berlin, Paris, New Haven, and elsewhere showed that there must be some reason, not as yet understood, for the apparently mysterious rupture of cylinders tested at pressures far beyond the liquefying pressures of the gas. The investigations of Pictet have revealed what is doubtless the cause of these explosions,—namely, the extraordinary expansion of the liquid with changes of temperature. Liquid acetylene is, without doubt, the most expansible liquid known. A given volume of the liquid at 32° F. becomes 1.07 volumes at 62°, and 1.24 volumes at 96°, thus expanding fully one-fourth of its original volume at the temperature of a midsummer day, or of a factory engine-room. When the cylinders containing the liquefied gas are only about half filled, the room for expansion is sufficient to provide for the increase in volume at any temperature at all likely to be experienced, and M. Pictet has fearlessly subjected such cylinders to the temperature of boiling water without accident. In the absence of this precaution the enormous expansive force of the liquid not only ruptures the vessel, but releases the liquid contained therein at a pressure at which its ex-

plosive power practically equals that of gun cotton. Since the quantity of liquid contained in a cylinder can readily be determined by weight, it is perfectly practicable to control the filling so as to provide for the expansibility of the liquid ; but, until this point is thoroughly understood and faithfully observed, the liquid acetylene must be regarded with caution. In no case, however, should explosions of the liquefied gas be confounded with supposed dangers of the gas at ordinary pressures, as the two are absolutely distinct.

Another method of storing acetylene in small bulk has recently been brought to notice in Paris by MM. Claude and Hess. This consists in dissolving the gas in acetone, a liquid which has the property of absorbing at atmospheric pressure thirty-one times its own bulk of acetylene gas. The gas may be dissolved in the acetone under pressure, and withdrawn from it by relief of pressure, much in the same manner as the gas in the siphons of carbonated waters is dissolved and withdrawn. This affords a convenient and safe method of storing a large volume of the gas in small bulk, and appears to be a valuable solution of the problem. The experiments of Berthelot and Vieille* have shown that, if the pressure under which the gas is dissolved in the acetone does not exceed about one hundred and fifty pounds to the square inch, there is no danger of explosion, but that at higher pressures the solution begins to partake of the properties of liquefied acetylene, and becomes subject to the same dangers.

With our present knowledge, the safe and satisfactory use of acetylene is within the limits of ordinary temperatures and at pressures below two atmospheres, and it is within those limits that the widest range of usefulness will doubtless be found.

The commercial side of the problem is one which, at the present state of experience, is limited by one controlling factor,—the cost of calcium carbid. All other elements are similar to details of ordinary manufacture, and can be determined with a reasonable degree of accuracy. Until a wider experience can be had, it is impracticable to predict just what may be expected from improvements in the manufacture of carbid. When the subject was first brought before the public, only small quantities had been made, and estimates as to the price at which it could be made by the ton were much lower than any price yet realized. The chief element of cost in electric smelting is that of power, and it is not difficult to compute the power required to effect the chemical and thermal reactions involved in the conversion of lime and carbon to calcium carbid. As one example of such a computation, the figures of M. Pictet are given, and, it may be added, these agree very closely with those of other physicists.

**Comptes Rendus*, May 10, 1897.

Taking the formula:

$$Ca\,O + 3\,C = Ca\,C_2 + CO,$$

and substituting the equivalent weights, we have:

$$Ca\,O + 3\,C = Ca\,C_2 + CO$$
$$56 + 36 = 64 + 28$$

1. The heat necessary to raise 36 grams of carbon to 3,000° C.:

$$0.036 \times 3{,}000 \times 0.46 = 49.68 \text{ calories}$$

2. The reduction of 56 grams of lime to 40 grams of calcium and 16 grams of oxygen involves a work of dissociation equal to 132 calories.

3. The heat necessary to raise 56 grams of lime to 3000° : = 33.6 calories.

From these are to be deducted:

4. Heat produced by the combustion of 12 grams of carbon to carbonic oxid: 28.59 calories.

5. Heat of formation of carbid of calcium, endothermic reaction: = 0.65 calories.

Taking the algebraic sum of these quantities of heat, we have, for the production of 64 grams of carbid of calcium, an expenditure of 184 calories, which is equivalent to 2,856 calories for one kilogram, this being the theoretical value, assuming an efficiency of 100 per cent. for the apparatus. This is equivalent to 5,141 British thermal units per pound of carbid, and, as one h. p. h. is equal to 2,545 B. T. U., the minimum theoretical amount of power required to generate the heat necessary to produce one pound of carbid per hour is 2.02 h. p.

This agrees fairly well with the limited information available as to the actual amount of power required in practice, so that, with an allowance of, say, 75 per cent. efficiency, the actual power required can be determined, and the question becomes one of economical power. The existing establishments are at points where water power is available,—at Niagara, at Neuhausen, below the Falls of the Rhine, and at the Heroult aluminum works at Froges,—and the influence of competition should soon determine a definite market price based upon the cost of manufacture.

From the foregoing discussion, while it may be too soon to draw definite conclusions upon all the points at issue, we may infer that acetylene as an illuminant has a positive value which for many purposes is immediately available; that it can be produced and used without greater risk or danger than is involved in the use of ordinary illuminating gas; that, in the compressed or liquefied form, it should be handled only by experts under well-ascertained conditions; but that notable advances must be made in its economical production, if it is to compete broadly with coal and water gas as an illuminating agent.

REVIEW OF THE ENGINEERING PRESS

The Smoke Nuisance.

MORE than ever the abatement of the smoke nuisance is demanded under the belief that its abatement is possible, and that the industrial interests which create it ought not to have any right to profit at the inconvenience and expense of immediate neighbors. The board of health of Philadelphia having requested The Franklin Institute to appoint a committee to coöperate with the board in the effort to abate the nuisance, the question came up for discussion before that body in April. The discussion was opened by Mr. A. E. Outerbridge, Jr., whose very able treatment of the subject (published in the *Journal of the Franklin Institute* for June) clearly sets forth the extent of the grievance, not alone in Philadelphia, but in other cities. He gave as the chief cause of the nuisance the increase in the use of bituminous coal in urban industries, and presented a *résumé* of the scientific investigations directed to smoke prevention, together with a statement of the principles underlying the problem. In the course of his remarks he brought out the fact that the "development of modern sky-scraper office-buildings surrounding industrial establishments and far overtopping their chimneys is rapidly changing old conditions," thus making the question of smoke prevention so important that it can no longer be neglected. The failure of some of the smoke ordinances passed in a number of western cities where soft coal is used is attributed to the ignorance of legislators. "An ordinance more than ten years old, making it a penitentiary offence for an individual to permit black smoke to escape from his chimney," is cited. "The very absurd and preposterous nature of the penalty made the ordinance practically a dead letter from its inception." The extent of the nuisance and the grievous damage inflicted are shown by quotations from a report that Chief Smoke Inspector Adams, of Chicago, made to the board of health of the city. Mr. Adams divides the people of Chicago into two classes: "(1) those who create a smoke nuisance; (2) those who are compelled to tolerate a smoke nuisance. One class has radical champions, who maintain that smoke is an irrepressible necessity—a concomitant of the commercial and manufacturing supremacy of Chicago; that smoke not only is not unhealthy, but that it is an actual disinfectant; that the advocates of smoke abatement are visionary sentimentalists, and, in a general way, they are emphatically opposed to any agitation of the subject." The second class "declare that the smoke nuisance is a positive menace to the health of citizens; that it has resulted in an alarming increase in throat, lung, and eye diseases; they point to ruined carpets, paintings, fabrics, the soot-besmeared façades of buildings, and to a smoke-beclouded sky, and demand that the smoke inspector do his plain duty under the law." In Chicago, there are more than 15,000 steam boilers, 12,000 of which consume soft coal. These are distributed over an area of 186 square miles. Inspector Adams says: "I know of an instance in which a restaurant firm so consumed $600 worth of coal as to cause an actual damage to adjacent property exceeding $25,000." He also cites "an apartment building, under the management of a receiver, protected by the court against the enforcement of the smoke ordinance," which, he states, "ruined the furniture and furnishings of every residence for two blocks in its neighborhood, and depreciated the value of adjacent real estate more than one-third of its former value." Mr. Outerbridge then reviews the different solutions of the smoke problem hitherto proposed. Theoretically, the best solution is the use of smokeless fuel. Such a fuel is petroleum. But for various reasons, among which is an inadequate supply, "we may as well abandon the idea of the probability of the general use of petroleum as

a fuel in this country." Secondly, the use of anthracite is not accompanied with the nuisance of smoke, but "it is an unfortunate fact that this admirable fuel has been proven unable to compete successfully with bituminous coal in the race for industrial supremacy." The anthracite output in 1895 was double that of 1880, while the production of bituminous coal was more than three times as great. Dr. R. H. Thurston, following Mr. Outerbridge, confirmed the statement that the smoke nuisance is preventable. He regards the question as largely a matter of finance; that is to say, the cost of smoke-abatement is the principal obstacle to its full accomplishment. Classifying the preventives which are more or less effective, he named legislation, operating through boards of health, as being, in his opinion, most likely to be effective. He does not credit the statements made with reference to its unhealthfulness, rather regarding the presence of some free carbon in the air as aseptic in its effects. A system of fines that would make the production of smoke more costly than its prevention ought to be imposed. "The difference in the costs of bituminous and anthracite coal being taken as, we will say for illustration, $2 per ton, the proprietor can bear a tax of that amount, if it should prove necessary on the part of the city to impose it; and this means about $4 per annum per square foot of grate surface. A fine of twenty-five to fifty cents a month per square foot of offending grate will thus presumably abate the nuisance under such circumstances. Very likely a much smaller sum may prove sufficient; but that is a matter for trial, and one to be settled by experience." Mr. William R. Roney, Professor L. N. Haupt, Col. Thomas P. Roberts, of Pittsburg, and others contributed to this interesting discussion. The consensus of opinion is that abatement of the smoke nuisance is possible. The increased cost of smokeless combustion will be the chief incentive of opposition to a general and effective movement in this direction. It has always been the case that great public reforms have been resisted by private interests.

Pot Holes in the Anthracite Region.

In an article by William Griffith in *Engineering News* (June 24) a description of these freaks of the glacial period is presented, and the action of water flowing through a considerable distance in streams (probably through crevices in the ice), aided by the stones kept rolling and rocking or swept about by the force of the water-falls, is assigned as the cause of these holes. Pot holes are often found in the neighborhood of channels gouged out by the irrepressible force of the superincumbent glacial mass, which carried along with it quantities of abrasive materials (such as sand and gravel), now found deposited in the channels and in the pot holes, the latter being generally filled with glacial drift. What is known as the "buried valley" of Wyoming is one of these glacial channels. In 1884, one of these pot holes was discovered in the anthracite coal regions, "when one of the chambers of the Eton Colliery at Archbald, owned by Jones, Simpson & Co., and located on the mountain-side high above the water-level, was drifted against a mass of round stones of all sizes, from pebbles to boulders a foot in diameter. Subsequent investigation revealed the existence of an oval-shaped shaft, from twenty to forty feet in diameter, worn through the rock from the surface. The walls of the pot hole were smoothly worn and fluted, and corrugated spiral curves showed the unmistakable action of water and stones. This pot hole had cut completely through the coal bed, and among the boulders in the bottom of the hole were quantities of of round lumps of coal, which had evidently been cut from the vein." This pot hole is now used as an air shaft for the mine. A wall has been built around the top, and "it may be inspected at any time. A second pot hole was found later at the same mine, about 1,000 feet northward of the first. It has, however, never been cleared of its contents of glacial drift." About twenty years previous to the discovery of these pot holes, a cave-in occurred at the Wyoming colliery, now the Lehigh Valley Coal Co., at Port Bowkly Station, on the Lehigh Valley Railroad. It was supposed that this

was the result of one of these pot holes, since the mines were filled with *débris* like that found in the other pot hole. The mine has since been recovered. Two serious mine accidents attributed to pot holes have occurred in the "buried valley," of Wyoming, since the Archbald pot holes were discovered. The latest of these occurred on March 1, 1897. On the afternoon of that day "the surface under the Wyoming post office began to settle. The mines were idle, and no one was working at this point. Inspection by the mine officers revealed the fact that a break had occurred near the face of the most advanced workings at the edge of the solid coal, resulting in a flow of water and quicksand, filling a large area of the workings, and carrying the *débris* to the foot of the shaft three thousand feet away." The volume of the flood, however, gradually diminished, and, the pumps being adequate for the emergency, the water in a short time began to subside, the flow of sand stopped, and the break checked and filled, not, however, until about seven thousand cubic yards of quicksand had been washed into the mine, causing a surface depression or cave about 2,300 feet in diameter and 25 feet in depth, which engulfed the pot hole completely and did some damage to three dwellings. The circumstances of this accident, and the evidences accompanying it, show unquestionably the presence at this point of a glacial pot hole of sufficient depth—fifty to seventy-five feet at least—to cut the vein of coal in which the mines were operated. The first rush of sand and water carried with it a quantity of water ground lumps, which were deposited near the shaft and in the gangway leading therefrom. Quantities of coal, worn round and smooth, were found deposited with the quicksand at points close to the work, showing that the bottom of the hole probably cut through the coal-vein. Fortunately, the miners had left their work a few hours before the break occurred. A stoppage of the mine for about six days resulted, but it is now in operation again. This is an abstract of a paper read at the meeting of the Anthracite Coal Operators' Association for 1897.

A Notable Feat in Irrigation.

SOME of the difficulties which have to be encountered by engineers engaged in erecting irrigation works are recounted in an interesting popular article in *Harper's Weekly* (June 12). The cultivation of arid lands depends, not upon the amount of land which can be cultivated in the heated region, but upon the water-supply which can be obtained by engineering methods. As a rule, irrigated lands have proved very profitable and productive, and the problem of obtaining water for irrigation is one of the most interesting that can be presented to the civil engineer. In the article named a feat in irrigation is described which, we think, is not generally known to the American public. This was simply a diverting of water from one watershed to another on the opposite side of the ridge. "This plan comprehends nothing less than the appropriating from the Pacific-slope water to supply a deficiency on the Atlantic slope, or of drawing water from the Grand river in Colorado to supply the farmers of the Cache la Poudre valley with water for their crops, or *vice versa*." This plan has already been carried out in the diversion of water from the head of the Big Laramie river, which, rising in Laramie county, Colorado, flows northward into the North Platte river, the head of the Cache le Poudre river rising in the same county and flowing in an easterly direction and emptying into the South Platte. "This feat has been accomplished by a company which owns a large system of irrigating ditches and reservoirs in the Cache la Poudre valley. Both the Big Laramie and Cache la Poudre rivers have their source in the Medicine Bow range of the Rocky mountains, in the neighborhood of Clark's and Cameron's peaks. These peaks rise some thirteen thousand feet above sea-level, and are never entirely devoid of snow; and, when the warm rays of the spring-time sun begin to beat upon their rugged sides, the snow and ice melt and fill all the streams with rushing torrents. The Big Laramie flows northward into Wyoming, where irrigation is not so far developed as in Colorado; consequently

its waters have not all been appropriated. The engineers found that, by intercepting one of its upper tributaries at an altitude of 9,500 feet above sea-level, quite a generous flow of this unappropriated water could be conducted, by the construction of a ditch around the steep sides of Clark's peak, and turned into Chambers lake, a tributary of the Cache la Poudre. Many difficulties, however, were encountered in the construction of this alpine canal. In the first place, the seasons are short in that altitude, and the work of construction could not be continued longer than the first of December, on account of cold weather, the snow falling at frequent intervals, and the ground freezing so that excavation could not be prosecuted. Again, the ditch must needs be constructed in many places along the steep side of the mountain, where the entire work was liable to slide out, or the ditch be filled with *débris* from a landslide from above. In other places it must be built through heavy timber; in others still through hard rock. At one point it was found necessary to tunnel for a distance of one hundred feet through solid rock, and at another point a flume four hundred feet in length carried the ditch across a deep depression in the mountain-side. For a great distance it was found necessary to build log curbing to sustain the outer bank of the ditch and to prevent its sliding down the mountain side." A ditch five miles in length, ten feet in width on the bottom, and from twelve to fifteen feet in width on top, is now in successful operation. At its upper end, its capacity is 242 cubic feet of water per second, and at the lower end 400 cubic feet. The increase in the capacity from the beginning to the end of the ditch is to accommodate the inflow of various small mountain streams. "The ditch is in charge of a superintendent and a crew of men for nine months in the year, —that is, from March until December,— and is patrolled daily and watched with the greatest care; for a leak might cause a break, and a break might carry out hundreds of cubic yards of earth work and make the ditch practically useless for days and days in the most critical season. During the summer months heavy showers of rain and cloud-bursts are frequent in these high altitudes, when water comes pouring down the mountain-side in tons. To obviate the danger of a break on account of a flood of water an automatic wasteway was invented. This is so arranged that water rising beyond a certain depth in the ditch lifts the waste-gate and relieves the strain on the banks of the ditch." There are connected with this ditch six storage reservoirs with a capacity of more than 600,000,000 cubic feet. This ditch supplies water for the Laramie county ditch, 71 miles in length, 20 feet wide at the bottom, and 30 feet wide at the top, which, constructed at a cost of $200,000, waters 30,000 acres of land. This ditch is connected with six storage reservoirs having a combined capacity of more than 600,000,000 cubic feet.

Steamships of 1862 Contrasted with Those of 1897.

UNDER the title, "The Place of Our Destination," the first part of a serial article by Professor John E. Sweet, in *American Machinist* (June 17), makes a comparison between steamships in the year 1862 and those of the most modern type. A vein of humor pervades Professor Sweet's articles, which adds much to the interest of all that he writes. He is well known as a keen observer in all matters mechanical. He describes a voyage made by him in 1862 from Boston to Philadelphia on the Cunard steamer America, and another made this year on the Lucania. The America will be well-remembered by many now living, but Professor Sweet gives some details of its dimensions which it is interesting to recall. "She was a wooden side-wheel steamer of, perhaps, 280 feet in length, from 2,000 to 2,500 tons' burden, with what were called side-beam engines, —that is, a vertical cylinder with its piston-rod connected to a crosshead above, connecting rods or links reaching down each side of the cylinder to the ends of two side levers, and from the other end of the beams a connecting rod reaching up to the drag-link cranks on the shafts; each shaft extending out to its own

paddle-wheel." The paddle-wheel ocean steamers have disappeared, and have been so long out of use that even those who can well recall them have almost forgotten their former existence. The comparison made between the old America and the modern Lucania shows enormous progress. The Lucania "is a double-screw iron steamer, 620 feet long, 62 feet wide, about 13,000 tons' burden, with two pairs of triple-expansion engines of 15,000 h. p. each." Not only the difference in size, but the difference in construction and sailing, is notable. Professor Sweet says that the two journeys were made in very similar weather, and under very similar conditions of the sea. The America pitched badly; the Lucania does not pitch at all, but rolls considerably. Professor Sweet says she rolls most in a smooth sea,—"a condition there is certainly no excuse for; for to prevent it is a simple mechanical problem, much less intricate than others in the same line." Professor Sweet humorously tells of the sea-sickness suffered on the old America, which has been replaced by *mal de mer* on more modern ships. "I well remember when my chum suggested a pint of sea-water as a remedy. I said I thought a point of land would suit me much better. He seemed to think it very funny; so one can see there has been a change in wit as well as in ships, for what was laughable then seems now as flat as a surface plate." An interesting point in the history of screw propulsion is noted as follows: "In the early days of screw propulsion, the most difficult thing they had to contend against was the governing of the engines, and during a trip in March, 1865, in the screw steamer City of New York, No. 2, no attempt—or at least no successful attempt—was made to govern the engine; as the ship pitches fearfully, the engines went like a wind-mill when the screws came out of the water, and slowed down to a quarter speed when wallowing deep in the sea. Suggestions were then made that the proper source to govern from was wells or chambers in the stern of the ship, and this means is now adopted. This system has been worked out so perfectly, that the Lucania is now perfectly governed in a rough sea; she will not race nor lose in such a sea over two knots out of twenty-two. The principle of the governor is simple. When the stern of the ship comes out of the water, the pressure in the chambers is reduced and the throttle closed; when the stern goes down, the pressure is increased and the throttle opened. The preventing of the ship's rolling in a smooth sea is not a more difficult, though a different, problem. When one stops to think what an insignificant thing a rudder is, and what it does under the worst of conditions, why should he question the efficacy of a rudder in the keel of a vessel to keep it from rolling? As the steersman guides his rudder by the compass, so, too, would the leveler guide his rudder (or fins —as would have to be used in a ship like the Lucania, which has no keel) by a level or plumb. It might not prove impossible to work the device automatically, but any attempt to hold the ship on an even keel would not do. The ship's natural position when careened by load or wind would have to be found; or, in other words, the thing desired would be to hold the ship as near as possible at a mean between its natural oscillations." Mr. Sweet's voyage in the America in 1862 was made in a little more than twelve days. The trip in the Lucania from New York to Liverpool required only a little more than six days. Neither the "pint of sea water" or the "point of land" was required in the latter voyage, as Professor Sweet declares himself to have been able to do duty in the dining-saloon three times a day.

Tall Office-Buildings.

IN a series of popular articles in *Scribner's* ("The Conduct of Great Businesses"), different writers have been endeavoring to display the characteristic features of some of the leading commercial occupations and enterprises of modern times. The fifth of the series (May number) deals with the modern high building, which, "whether it be ugly or beautiful, whether it express pleasant or disagreeable traits and truths, is distinctively of this day and this country, and, containing all the other modes of en-

terprise, is comprehensively typical." It is regarded as a necessity from which there is no escape. Business men, finding that their business had outgrown their buildings, and unable to secure additional room on adjoining lots, were confronted with the alternatives of restricting the growth of their enterprises, of removal, or of starting branch establishments at more or less different locations. A large number preferred to retain the existing site and keep their business under a single roof; this could be done only by going skyward. The passenger-elevator, enabling a tenth or twelfth story to be reached as easily as the second or third, removed all physical difficulty, while architects and engineers, perceiving the situation and realizing all its demands, found themselves in possession of ample resources for carrying out the construction of buildings twenty stories high or more, if required. "The prices charged for a given space in one of the early buildings called high in New York will show how speculative, and how far astray, were the first reckonings on the effect of the elevator. The building was finished in 1868, and the manager let a suite on the top floor for $850 a year. He raised the rent the next year to $1,250, and, thinking the limit reached in that figure, signed a contract for a five-year lease. Bound by his agreement, he had to refuse offers rising gradually to $4,500, which he got readily at the end of the sixth year. People became accustomed to the elevator, as their fathers did to the steam cars, and now the top stories of high buildings bring in more rent than the middle floors." The financial aspect of tall buildings has invited capital, and, investments in this class of building having proved profitable, there is at present no abatement in the favor with which it is regarded. A business phase of the enormous value that can thus be placed on a comparatively small plot of ground is beginning to develop itself. "In most of our greater cities a man can borrow money at nearly as low a rate on real estate in the financial centers as he can on high-class bonds, and the difference is disappearing. The bonds have the advantage of their divisibility; the holder of a million dollars' worth can hypothecate them in any number of parcels at even rates, while the owner of a piece of real-estate of equal value has to put a mortgage on the whole to secure a loan, however small, and the first lien lowers the value of all subsequent mortgages. To obviate this difficulty, companies are incorporating to fund real estate, so that its value can be handled in the form of stocks and bonds, just as the securities of railroads and manufacturing companies are handled in the financial market." There is a tendency apparent to make tall buildings serve as residences for bachelor tenants, as well as for offices; and a restaurant has long been a feature of some great office-buildings. The future may see great hotels in which business men will reside as well as conduct their business, and which will supply not only food and lodging, but even amusement.

Excessive Rainfalls.

THE determination of the maximum quantity of water precipitated in any given time is one of the most important data sought by engineers when called upon to design a sewer and drainage system in any locality. If excessive demands for drainage are not provided for in advance, there is certain to be trouble, for which the designer will be held responsible. Mr. Alfred J. Henry, in the *Engineering News*, (June 24), calls attention to the fact that, in some of the heavy storms of the past year, many central cities have found their facilities inadequate for the discharge of the precipitated water, and damage to property and litigation have resulted from these failures. In view of the importance of the subject, Mr. Henry now makes what he thinks is "a first attempt to draw some useful deductions from the records of automatic rain-gages in use at weather-bureau stations," and has prepared a "table showing the accumulated amounts of precipitation for each five minutes during all storms in 1896 in which the rates equalled or exceeded one inch per hour at all stations of the weather bureau furnished with self-registering rain-gages." He has also tabulated for the cities of Washington, Savannah, and Saint Louis the percentage

of cases wherein the maximum intensity of rainfalls occurred within from five to sixty minutes from the beginning of the storm. The author suggests that, "if we select from the whole number of individual storms those shorter periods during which a very high rate was maintained, and plot the rates per hour as abscissæ in a system of rectilinear coördinates, we obtain, after connecting the points so plotted, a curve of probable maximum intensity." The records justify the division of excessive rains into two broad classes,—"(*a*) rains of great intensity and short duration and (*b*) of light intensity and long duration. Of these two classes, those of the first are by far the most damaging and destructive. In extreme cases, ninety-five per cent. of the downpour may quickly find its way into natural or artificial drainage channels. A rainfall of one-half inch in linear depth represents about 11,312 imperial gallons per acre. Assuming that in extreme cases only five per cent. is absorbed, it is easily seen how great a quantity of water must flow into the drainage channels." Conditions for sudden condensation and precipitation of water vapor are "(1) a strong vertical temperature gradient; (2) high surface temperature and humidity,—in fact, the general conditions of humidity and instability of the atmosphere necessary to the formation of thunder-storms and tornadoes." Of the first class, the cloud-bursts of the mountainous and arid regions of the west are the most violent. These cloud-bursts may occur in any of the "mountainous localities throughout the entire territory bounded by the British possessions on the north and the Mexican border on the south, the foot hills of the Rockies on the east and the sierras on the west." While the downpour of water is extremely violent in this class of storms, it usually covers only a small area. The amount of water which falls in a short time is often surprising. An instance is given of a rain-fall of 8.8 inches in a single hour. Another case where 11.5 inches fell within an hour is named. It is evident that the records of the weather bureau can be made available for the supply of needed engineering data.

Electrolytic Precipitation of Gold from Cyanid Solutions.

THE *Mining and Scientific Press* credits to the *Transactions of the Chemical and Metallurgical Society of Johannesburg* the translation of a paper read by L. Ehrmann, wherein the simplification of the electrolytic process of precipitating coal from cyanid solutions is described. Professor Ehrmann states that the extraction of coal from cyanid solutions has assumed an importance that renders it nearly a capital subject of communications to the society named. "The zinc process has been in great favor on account of its simplicity, and very successful in general practice; but there are cases when either it is to be considered too slow, or the percentage of gold extracted from the solution too low. This is the reason why, principally with poor solutions, the electrolytic processes are used, when the simpler method of zinc boxes seems ineffective." He holds that the electrolytic processes are the best because they can be regulated, but they exact more care and technical knowledge than the ordinary zinc process. He lays down the principle that electrolysis of the solution produced in the zinc boxes by the contact of two different metals, instead of being produced by an external source of electricity, simplifies the electric process. He calls attention to the fact that elevation of the temperature, which facilitates the chemical reactions, and makes them more complete and rapid is a neglected question. His paper deals principally with the results of experiments which he has made in this way. In some cases zinc shavings were used in the ordinary way; in other cases they have been more or less coated with a very thin film of copper. The solution generally giving the best results was an ammonia cupric, cheaper and more effective than tartrate or other organic solutions. In reply to a question, Mr. Ehrman stated that the zinc he experimented with was the ordinary zinc obtained in Johannesburg. He would not make the experiments with pure zinc, because he wanted to experiment from a practical point of view. The method of experiment is dealt with at length, with

tabulated statements of results. The results of all the experiments are favorable to the action of the zinc-copper couple and hot treatment, showing that hot treatment precipitates as much gold in two hours as cold treatment does in twenty-four hours. The difference in results obtained with hot solutions was confirmed by some of the members present, although the amount of difference claimed by Professor Ehrmann does not appear to have been reached by the other experimenters.

The Present Standing of the Steel Truck.

THE gradual substitution of metal for wood in various kinds of construction is a feature of the age. Although wood ties are still so widely used in American permanent way that their possible future is scarcely ever considered by the general public, railway men have long been weighing their merits and demerits as developed in patented inventions and such designs as have been put to practical tests. In car-building any observer might have seen that metal trucks for freight cars have been supplanting wood. In the *Railroad Gazette* (June 4) the present standing of the steel truck is editorially discussed, while steel underframing for freight cars is the burden of an editorial in *The Railway and Engineering Review*, noticed below. The fact that this increase in the substitution of metal for wood has become a familiar topic in publications devoted to railroad affairs and interests is a plain indication of the trend of progress. The *Railroad Gazette* says that, "among men of inventive mind and men looking about for new fields, the design of a successful steel truck is looked on as one of the big prizes still possible in railroad engineering." Since the completion of the first Fox truck in the early spring of 1891, new designs have appeared each year, and our contemporary notes that the last year has been probably more prolific in this line of advance than the five years preceding it. The lay reader might perhaps infer from the remark relating to the completion of the Fox truck in 1891 that metal trucks are a more recent invention than they really are. But a continuous frame iron truck has been in use on the Boston & Albany Railroad for thirty years. The *Railroad Gazette* quotes a permanent official of that road in high praise of this truck as a mechanical structure. A metal truck costs more than the old style of truck, but, when well designed, is "practically indestructible except by wreck," and the cost of current repairs is very much less.

Steel Underframing.

THE *Railway and Engineering Review* (June, 1890) prints under this heading the report of a committee, submitted at the Master Car Builders' Convention. This committee of five, appointed to prepare individual designs for steel underframing, found, after considering the subject in two meetings, that some degree of uniformity in general dimensions is advisable. In order to secure an expression of opinion upon the most desirable inside dimensions and width of door for a standard 60,000-pound capacity interchange box car, a circular letter of inquiry was addressed to all the leading railways requesting information. Answers were received from most of them. Private car lines were not consulted, because their cars are mostly special, and their dimensions might not be desirable for general use in interchange service. The result of the inquiry was the choice of the following dimensions,—to wit, (*a*) inside length for standard box car, 60,000 pounds' capacity, 34 feet; (*b*) width, 8 feet 4 inches; (*c*) height from the top of floor to the top of the plate, 7 feet 6 inches; (*d*) width of side door, 5 feet 4 inches; (*e*) width of end doors (when end doors are used), 24 inches; (*f*) height of end doors, 36 inches; (*g*) height from the top of the rail to the top of the floor, 4 feet two inches. The report says: "The design should show the end still flush, and not projecting beyond the siding." A very careful consideration of practical points, both mechanical and commercial, was given to the subject, in working out the designs. These designs are printed, with descriptive text, as part of the report.

THE BRITISH PRESS

Day Loads for Central Stations.

OBVIOUSLY the earning of maximum profit by a power plant of any kind depends upon its running at its maximum rate of output for the maximum fraction of a solar day. The maximum fraction of the day will depend, of course, upon the conditions of working. Electric-lighting stations are handicapped by the fact that they can run at the maximum output for only a very small fraction of the twenty-four hours of a solar day. At a convention of the Canadian Electrical Association, the proceedings of which are published in the June number of the *Canadian Electrical News*, Mr. J. A. Kammerer discusses the ruinous effects of many of the old business methods of central-station managers, and notes the fact that the energies of these managers are now being directed "to retrieve what has been lost in the past in this respect." Not only are they completely reconstructing or rearranging their plants, but they are giving attention to the study of efficiency as a matter of the first importance to successful working. They are also seeking other means of procuring remunerative returns, and, as increase of rates cannot be looked for, they are reaching out for additional income. "Such additional revenue must be obtained from increased and prolonged use of current, to obtain which means of having current used for other purposes than illumination must be found, and consequently use in the day-time, or a 'day load,' as it is called, must be secured." Mr. Kammerer combats the claim that, because the business of electric-lighting companies is night work, they should not look for a day load, although he admits that this, "at the first blush, looks reasonable;" but he adds, "were the margins on the woolen mills or other commodities as small as they are in most of our cities and towns on electric lighting, the woolen mill would either have to close up, or make its plant investment work day and night to make ends meet." A central station used for lighting only has a maximum load for scarcely two hours out of the twenty-four. "Its maximum investment is, therefore, only exerting its full earning power for less than two hours instead of ten or twelve hours daily." Of course, fixed charges run for the entire time, as much when the plant is working at a minimum rate as when it is producing its maximum amount. Mr. Kammerer shows that the multiphase alternating system, which permits of the supply of power as well as light, meets the ordinary situation at the present time, and he advises the cultivation of a day-lighting service among merchants, etc., there being many situations wherein an artificial light would be of use during the day as well as at night. As to industries to which power can be supplied during the day by the multiphase lighting current system, there seems to be no lack. There is the butcher with his meat-chopping machine, the baker with his dough mixer, the newspaper with its printing press, the foundry with its line of shafting to drive, and the planing mill with its machinery to be kept going throughout the day, in every town, while other and larger industries will be attracted to a town in which a day power service may be obtained. These different industries, all using power during the daytime, tend to create a steady load line, which is especially desirable, as it increases the number of hours in which the investment is exercising its earning power, and helps to increase and secure the maximum load line throughout the twenty-four hours.

Wood Pavements and Sanitation.

ON account of the porous and absorptive character of the material, its proneness to decay when exposed to atmospheric influences, its softness, and the failures which attended the earlier experiments in wood paving, this class of road surfaces fell into disrepute in America. On the other hand, in Paris, where asphalt paving has become highly popular, the failure of the initial experiments in wood paving has not discouraged further effort, and that city has to-day

a surface of 540,000 square meters of wood paving, so well liked that, not only in the French capital, but in provincial cities, the demand for it is constantly increasing. *The Sanitary Record* (June 11) discusses this subject from the standpoint that "the model roadway is that which commands cleanliness and dryness. A scavengered street, with well-flushed kennels, is never an unhealthy street." If the road be properly bevelled, the surface water is thrown off on either side, pools cannot form, and breeding-places and refuges for disease-spores are not created. The engineering requirements of a good roadway are that it must not be too rough or too smooth; horses must be secured a grip—a surety of footing. This will explain the disadvantages of asphaltum when in a "buttery" or greasy condition, and why hardness in wood is not in itself a recommendation. "A good road ought to produce from wear and tear but little detritus. Judge of what the latter can be, when the Seine, in 1879, annually received no less than 330,000 cubic yards of Paris street mud. The pavement was then in granite, whinstone, and porphyry, in addition to macadam surfaces. It is calculated that the total space between the joints of paving-stones equals one-third of the set-stone area. In some of the leading Paris thoroughfares corresponding with the main sewers the latter are provided with perforated iron catch-baskets, into which the street water with its charged sediment falls. The latter is retained and duly extracted. Wood pavement does not suit all kinds of traffic, or roads of steep grades. However, in Paris, immense trucks, drawn by five or seven horses, and transporting solid ready-dressed blocks of building-stone of seven to ten tons in weight, pass without injuring in the least the wood-paved streets." These wooden roads are made in a very thorough manner, and it is upon this thorough workmanship that their sanitary excellence almost wholly depends. An indestructible water-proof foundation or bed of best Portland cement concrete, covered over with a coat of liquid mortar, is provided, and allowed to dry sufficiently before the wood blocks (Swedish pine) are laid down. This wood is naturally very resinous, and therefore resists atmospheric agents. It is also said to be very elastic, and so homogeneous that it wears very evenly. Its hardness is sufficient for durability, but not so great as to make the roads slippery. "The borders or kennels have the blocks laid longitudinally, but the joints are not filled in, in order to allow for the wood swelling or dilating. But the interstices of the blocks composing the road proper are filled in with a liquid mortar. The surface is next covered with a special gravel, prepared from broken porphyry, which easily penetrates into the tissue of the wood, forming a kind of indurated and impervious topcoat." This topcoat renders the pavements much less slippery than it would be without it. Such a pavement will last for from eight to ten years, and the price named for it in Paris ranges from twelve to sixteen francs per square meter. The pitch pine of Florida is said to be excellent, but is dearer than the Swedish pine. The blocks are not laid down in their natural state, but are first creosoted, after having been divided into three different qualities. The creosoting is done by the municipality, which has a factory that turns out 13,000 blocks daily. This number of blocks is sufficient to pave 300 square meters. The cost of repairs for such a road is named as two francs, while that for stone is only one franc. A very great deal of attention is paid to the cleanliness of the streets in Paris, and from this, doubtless, the sanitary repute of the wood roads has gained very much. While the wood roads are more costly, they are regarded as a luxury.

Transmission of Power.

TRANSMISSION of power should not be confused with transmission of energy, yet such confusion is often manifested by writers upon mechanical subjects. Such confusion can even be detected in an article under the above title in *The Engineer* (London, June 4). A trolley wire conveys energy, not power, from the power house to the motor of an electric car. The energy

thus conveyed performs no work, except in overcoming the resistance of the wire, till it reaches the motor, wherein it is converted into power, which is expended in the performance of work. The boiler of a locomotive does not transmit power from the furnace to the water in the boiler; it transmits that form of energy known as heat; strictly speaking, the boiler does no work. By a figure of speech, we say a boiler "works well, or ill," as the case may be; but, when we consult our mechanical and thermodynamical definitions, we find no warrant for saying that a boiler works, or that it transmits power; what it transmits is energy—a very different thing from either power or work. The steam pipe leading from the boiler to the steam chest of an engine cylinder does not transmit power; it simply transmits the heat energy generated in the boiler; only when the steam reaches the cylinder and the piston moves, energy is converted into work, which,when quantitively expressed in units of work performed in a specified time, is power. On the other hand, rope transmission, bell transmission, shaft transmission, etc., are examples of power transmission. The article referred to in *The Engineer* criticises the lack of judicial spirit with which the members of the Institution of Civil Engineers recently debated this subject. If some percentage of energy be required at a distance, derived from a primary source of energy, and if to get that distant energy as a derivative from the primary, mechanical power be transmitted between the two points, there will be required two conversions; first, energy must be converted into mechanical power, and, second, this mechanical power must be, in its turn, converted into energy. If, on the other hand, mechanical power be desired to be produced at a distance from some primary source of power, and to gain that power at a distance energy be transmitted, there will again be two conversions,—to wit, power into energy, and energy into power. If we are to agree in thought, we must agree upon the symbols of language used to express thought. The most rancorous historical debates and disagreements have been the offspring of mutual misunderstanding. In the debate reviewed editorially in *The Engineer*, it is true, the remarks were mostly confined to practical topics, but in this age it is so impossible to divorce practice from theory that, if one is confused in his theory, he is almost certain to be somewhat wrong in his practice. One reason for disagreement at the meeting referred to appears to have been the short time (ten minutes) to which each member was limited in his remarks. Such a limit in debating a subject so large in every way might well breed an impatience not provocative of good temper. This debate, as reported, is, however, full of interest to mechanical and electrical engineers.

Precautions Against, and Recovery After, Explosions in Coal Mines.

AN attempt to codify a set of rules to be observed by owners and managers, and by men working in coal mines,—rules calculated to prevent explosions so far as precautionary measures can avail for such a purpose, to mitigate the dangers to which the men are exposed and the damage to mines and machinery resulting from explosions, and to facilitate the recovery of, first, the living, and, second, those killed in explosions,—is made in a very able and comprehensive paper by Mr. Garforth, read before the Confederated Institution of Mining Engineers, last June. Mr. Garforth expressed surprise that, considering the full and detailed accounts which have been written during the last century by experienced and scientific men to explain the cause of colliery explosions, and to suggest precautions for their prevention, the colliery men do not to-day possess a code of rules for practical use in a time of great excitement and confusion, such as usually follows a colliery explosion. He thought that, "if the manager had before him a form of rules and knowledge of the means which had proved successful at a neighboring colliery some years before, supplemented by information as to the mistakes committed at another colliery by which a second explosion and loss of life occurred, it would help to show him, at a critical moment, what to do and what to

guard against. It might also tend to reduce the feeling of helplessness more or less experienced when man is face to face with a calamity brought about by the forces of nature." The rules presented by Mr. Garforth are forty-two in number, and fill nearly three columns of the *Colliery Guardian* (June 11). Eighteen of these rules relate to precautionary measures, and the remainder to measures applicable after an explosion. They bear the unmistakable stamp of practical experience in coal-mining, and, as presented, they met with the general approval of the members, who, after the reading of the paper, engaged in an interesting discussion. Our readers must consult the article itself for the text of the rules. No attempt at an abstract would do them justice. The president of the association, Mr. Lindsay Wood, said that the suggestions in the paper would disseminate knowledge, the great safeguard for the prevention of accidents. He also suggested that the rules ought to be classified, the duties of the managers and owners being placed in one category, and those of the men in another. A member present remarked that these rules would impress upon the management the proper measures before the conditions arose, and he thought this a very important consideration. Some people think it sufficient to get the appliances when an accident has occurred, but this delay places them at great disadvantage. They would feel much more at ease if they had such possibilities constantly in mind, and had provided the precautions needed to meet them. He thought the rules ought to be printed and constantly exposed on the pit-heap or in the cabin for reference. Another member thought the rules should be embodied in questions included in the examinations for managers' certificates. These remarks sufficiently indicate the favor with which Mr. Garforth's paper was received, as well as its practical value.

Steam Pipes as a Cause of Fires.

FEW questions relating to the details of modern construction have elicited more discussion or given rise to more dispute than the assumed freedom of low-pressure steam pipes from the danger of igniting woodwork. While the direct ignition of new wood by the heat of low-pressure steam pipes may be regarded as impossible, investigation has proved, beyond a doubt, that the continuous action of temperatures, ranging from 212 to 225 degrees F., will produce in wood constantly exposed to the action of external air a condition wherein it will spontaneously ignite by absorption of oxygen. A number of fires in buildings have been attributed to this cause. The fact justifies the enforcement of the underwriters' rules for protecting woodwork near which steam pipes are placed, by covering it with metal plates, etc. Not only in buildings have fires thus been originated, but also in mines. In connection with the dangers attending the use of steam pipes in mines, the effects of steam upon wood are noted by Mr. A. L. Steavenson, in *Iron and Coal Trades' Review* (June 11). Reference is made by Mr. Steavenson to the experiments of M. Violette in a study of thermometric conditions or temperatures necessary to transform wood into charcoal. When wood has been thus carbonized, it becomes subject to spontaneous combustion due to the rapid absorption of oxygen, by which its temperature is elevated to the point of ignition. Indeed, it may be suspected that the absorption of other gases might also raise the temperature of such wood to the ignition point, which, if once reached, would be maintained by active combustion in the open air. M. Violette determined that, according to different methods of carbonization, he could obtain from fifteen to forty per cent. of charcoal, with marked differences in chemical and characteristic properties. At temperatures as high as 392 degrees F., he could not get good, black charcoal, but at 570 degrees the product was uniformly good. Other authorities have, however, determined that exposure of wood to a much lower temperature will produce results which M. Violette failed to secure, if sufficient time be given for slow action to take place. Professor Vivian B. Lewes says that, if coal be kept at a high temperature, but still far below its igniting

point, its ignition is simply a question of time, a temperature of 120 degrees being sufficient to create a dangerous risk. There seems to be no doubt that an analogous condition may be produced in wood, if kept constantly for a long period at a temperature considerably above the normal. Such wood becomes brown in color and friable, and seems to possess the power of absorbing oxygen, though in a less degree than charcoal. Of course at higher temperatures the danger is much increased. Examples are cited wherein wood has been discovered in a state of ignition while in actual contact with high-pressure steam pipes, and this contact was undoubtedly the cause of the burning. The practical application of Mr. Steavenson's paper to the precautions needed to guard against fires where steam heating is employed is obvious.

German Light Railways.

A DISPATCH to the British foreign office from Mr. W. S. Harris-Gastrell, commercial attaché to the British embassy in Berlin, contains a memorandum upon a movement for furthering a proposed extension of light railways in Germany, in which the State is desired to participate. An abstract of this memorandum printed in the *Board of Trade Journal* for June contains a brief history of light railways up to the present time, and gives the outline of a new bill now before the house of deputies for the extension of the State railway system and its participation in building store-houses for grain. This "Auxiliary Railway Proposal," as the bill is named, provides for (*a*) the expenditure of a sum of £2,970,800 on branch railways; (*b*) the construction of light railways for a sum of £400,000; (*c*) the erection of agricultural store-houses for grain, at a cost of £100,000. The choice of the new branch lines has been expressly governed by the consideration of bringing the light railways into connection with the main lines, in order to more thoroughly complete the railway system. The total expenditure contemplated is £3,470,800. Of the £2,970,800 which it is proposed to expend on branch railways, £299,400 are budgeted for working requisites and appliances, rolling-stock, etc. Mr. Gastrell says that "light railways ("Kleinbahnen") in Prussia are regulated by a law of July 28, 1892, which kept in view the special object of attracting private capital to this useful agricultural undertaking. The reports on these lines show that a considerable and rapid development has taken place by the aid of private capital, but, of course, only on those portions which promised fair returns on the money invested. This was not the case with those lines started merely with the object of developing adjoining lands. It was clear from the very beginning that it was possible to build such lines only with certain help. Hence the power given in the law on light railways to the provinces to allot part of their revenues for their furtherance. Although some provinces, such as Hanover and Westphalia, at once made extensive use of this power, it was not much employed elsewhere until State aid was given to these railways. By the law of April 8, 1895, £250,000 was granted for this purpose, and a further £400,000 was added thereto by the law of June 3, 1896. These sums were applied to create such light railways as were deemed necessary in the interest of the public, but which could not be built otherwise than with State aid." Up to 1897 the sum of £250,000 has been granted or promised in different forms of subsidy to railways having an aggregate length of about 625 miles. This appropriation of £650,000 will be fully absorbed by the new scheme, if it is carried out as proposed. The £100,000 allotted in the bill for subsidizing grain store-houses is additional to the $150,000 allotted by the law of June 3, 1896. The roads to which the allotments are to be distributed are specified in the memorandum.

A Remedy for Urban Overcrowding.

THE ever-increasing squalor of workingmen's homes in cities and large towns commands the pity of all philanthropists. Scheme after scheme for the amelioration of the conditions under which the majority of the earners of wages are compelled to pass their days has been brought for-

ward. Some of these have been tried with, at most, only partial success; the majority of those submitted to actual experiment have lamentably failed. The result is not encouraging for the success of new schemes, but, all the same, Mr. Stanley Boulter, in the *Illustrated Carpenter and Builder* (June 11), publishes a plan which, carried out, he thinks would brighten the lives of the British working class, and enable industrious workers to provide a real home for themselves and families. Incidentally, the encouragement of thrift and the influence of an effort to reach a higher plane of living, by saving, would, it is thought, do much toward elevating the moral status of the class which it is proposed to benefit. The chief characteristic of the scheme is the extension of the principle of the "Irish Land Purchase Act," passed by the Unionist party in 1885. Under this act a tenant may purchase his holding, the government providing the purchase money, to be repaid by the tenant in forty-nine yearly instalments. It is said that these yearly instalments for the most part represent an annual sum considerably less than the rent. An example is given of holdings at twelve years' purchase on the estate of Lord Shannon, where the rent was £20 a year and the purchase price was £240. This sum advanced by the government required the repayment of £10 per annum for a period of forty-nine years, at the expiration of which the purchaser would become the absolute owner of the property. Mr. Boulter has consulted with eminent authorities upon the values of real estate in the suburban districts of London, and is confirmed by these in his estimate that ten years' purchase of the gross rent is a reasonable price to place upon freehold workmen's dwellings. For a period of sixteen years, with interest at three per cent. per annum and what is considered a fair sum for parochial and water rates in addition, the weekly saving necessary to meet the annual payment would be, for forty-seven years, 4s. 7d., and, for sixteen years, 7s. 9d. These are extremes; we omit the figures for terms of years between. The repairs would, however, come upon the tenant, but most workingmen in mechanical vocations are competent to do for themselves the more ordinary repairs required for such cottages as would be provided. On this basis, Mr. Boulton proceeds to work out the details of the scheme, considering the topics of punctual payments, the character of the buildings to be erected,—for which he gives plans and elevation,—the removal of tenants, and provision for migration.

The Victoria Bridge over the River Dee.

THE various methods of constructing movable centers for bridges may be classified in three categories, according as the movable part swings horizontally, or vertically, or is moved longitudinally, to open a space for the passage of vessels. A bridge recently erected over the River Dee, described and illustrated in *Engineering* (June 11), comprises some rather unusual features in the construction of the movable center span. The bridge consists of three spans with two masonry abutments and two intermediate piers made of screw piles. There are ten 6-inch solid steel piles in each of the intermediate piers, fitted with Barber's patent mushroom screws, and driven from eighteen to twenty feet into the river bottom. The total length between the abutments is 397 feet. The fixed spans are each 140 feet long by 25 feet wide, carrying an 18-foot roadway and two paths each 3 feet 6 inches in width. They are constructed of steel lattice girders, attached to the screw-pile by riveted cap girders. These support a trough deck platform, with a roadway of concrete covered with asphalt and wood paving. The movable center-span made is in two halves, 160 feet long, which travel in and out of the fixed spans, meeting in the center of the river. The platform of each is deflected downwards a distance of 75 inches, so that it can pass under the platform of its correlated fixed span. Hydraulic rams and an arrangement of steel wire rope are employed to move the separate parts of the movable center, each being carried on six cast-iron flanged wheels placed under the girders. A pressure of 750 pounds per square inch is employed in

the rams, which are each 8 inches in diameter by 11 feet 6 inches in stroke. The rams are attached to the cross girders of the fixed spans. Vertical duplex steam pumps are employed to generate the pressure in the accumulators. The hydraulic machinery is in duplicate, so that the bridge cannot be crippled by the breaking down of the apparatus. The power house is situated near one of the abutments, and the water is carried across the stream in a pipe to the machinery of the opposite section. On account of a tidal phenomenon known as the "bore" in the River Dee, great difficulty has been encountered in keeping the pipes which convey this pressure in good working condition. At the turn of the tide this "bore" or wave is seen rushing up the river at a speed of four or five miles an hour, and, as the waters of the river are shallow, and the height of the wave varies from two feet to four feet, the scouring effect upon the river bottom is so great as to completely alter the character of the bed. This action has resulted in scouring out the bottom of the river under the transverse pipes, leaving them to a considerable extent unsupported. The pipes are thus so much strained as to cause them to leak. Much ingenuity has been expended in the effort to avoid this difficulty. Copper pipes of 1½ inches in diameter, with screw unions, are now employed. An experiment is to be made with solid drawn lead pipes bound externally with copper wire. It is thought that this will give the required flexibility to meet the change in the condition of the river bottom. It seems to us that the electrical transmission of power across the stream would avoid the difficulty described, and would not cost as much as the pipes; but there may be reasons why this is impracticable.

Facts Pertaining to Wrought Iron and Mild Steel.

PROFESSOR A. Humboldt Sexton, in the *Practical Engineer* (June 18), says that these materials are nearly alike in chemical composition, both being very pure forms of iron containing not more than 0.5 per cent. of carbon; but they differ very much in their physical properties, as a result of different processes to which they are subjected. Wrought iron is produced from the common pig by the well-known process of "puddling," while one of the first steps in the production of mild steel is the melting of the crude material. Mild steel has come to the front, and has for many purposes completely superseded wrought iron, which once held the position of the only reliable metal for use in the constructive arts. The day of wrought iron is not over, however, for, although mild steel has taken its place for many purposes, the out-put of malleable iron in the Scotch works for 1876 was probably greater than that for any year since the commencement of the Scotch malleable iron industry. Iron or malleable steel may be made directly from the ore, and both of them have been so made in the past; but both are now prepared from the pig iron, which may therefore be considered as the crude material of both. The conversion of pig iron into either malleable iron or mild steel involves the removal of impurities, all of which, except sulphur and phosphorus, are more easily oxidizable than iron. Under suitable circumstances these may, therefore, be burned out. The puddling process differs very little at the present day from what it was when introduced by Cort. The methods of manufacture and the physical differences arising from differences in these methods are the principal topics dealt with in this article.

Railroad Bridges and Buildings.

IN the *Railway Magazine* for April is a general article by Mr. Walter G. Berg, which, under the above title, sets forth in an authoritative way the fact that this class of work has not escaped the specializing tendencies of the age. "The department of bridges and buildings of a railroad calls for a much greater special technical knowledge and practical training than is usually assumed by the general public and even by many railroad men, and, no doubt, far exceeding the expectations of the originators and pioneers of railroad construction." From this standpoint he summarizes in an

interesting way the nature of the work now employed in the department of bridges and buildings.

Secondary Minerals in Ore Bodies.

THE purpose of an article by E. Moriarty Weston in *The Australian Mining Standard* (March 18) is the stimulation of interest in observation and collection of facts pertaining to secondary minerals in ore bodies. The author, as far as possible, avoids theorizing upon the occurrence of the ore bodies themselves, and confines himself to the study of the secondary minerals as one of the most fascinating of subjects to mineralogists and geologists. Though the paper is necessarily technical in its treatment of these minerals, it also touches upon elements of popular interest. All the natural objects around us are undergoing chemical changes, although it is sometimes difficult to school ourselves into a full and constant realization of this fact. It is such changes that have produced the soils overlying the disintegrated rocks, and it is such changes to which the secondary minerals in ore bodies are ascribable. There is a striking analogy in the formation of some of these minerals to the formation of scale in steam boilers, the secondary formations in such cases being deposited from solutions. Such deposits take place often under slight changes in physical conditions, as is seen in the stalactites and stalagmites in caves. Minerals are often held in solution in water containing carbonic acid. The escape of this acid resulting from changes in temperature and pressure is often the cause of deposits of the material previously held in solution. Thus also gold may sometimes exist as a secondary mineral, as in quartz when it is seen to be surrounded by a greenish or red deposit of the sulphate or hydrated oxid of iron. The description of the chemical reactions through which gold thus occurs is too technical for our present consideration, but it, and the entire article, will interest students of mining and metallurgy.

Irrigation in the Northwest.

IN a very interesting and instructive paper read by Mr. William Pearce before the Association of Ontario Land Surveyors (*Canadian Engineer* for June), he states that few persons, if any, reared in a humid climate and afterwards residing in an arid or semi-arid one, where irrigation is needed, have not been impressed "with the neglected opportunities in irrigation in the humid portion." Even in the humid regions, irrigation is operated to a much greater extent than people residing in such regions are apt to appreciate; witness the almost daily watering of plants, shrubs, and trees by gardeners. The Dominion government instituted surveys in 1894, gaging streams and collecting data with reference to the amount of water available, such portions of the territories as are best adapted to irrigation, the location of sites for water storage, etc. The storage of water has a very important bearing on the conservation of forests. It is important that no time be lost in making the necessary reservations for storage in the settlement of new tracts, because the construction of roads and railways naturally occupies points most vital in storage of water at minimum cost. As an example, Mr. Pearce cites a report of the United States geological survey to the effect that at one point in the Rio Grande the creation of a reservoir at the best point would necessitate the reconstruction of a railway involving an outlay of hundreds of thousands of dollars.

THE FRENCH AND GERMAN PRESS

Recoil Pistols.

THE success of the Maxim automatic rapid-firing gun, in which the mechanism is operated by the force of the recoil, is well known. The same principle has now been applied to pistols, a very successful recoil pistol having been produced by the famous maker of small arms in Germany, Herr Mauser. The original idea of utilizing the force of the recoil is due to Bessemer, who suggested it as long ago as 1854, and the applications to disappearing gun carriages as well as to the Maxim gun have been long enough in use to demonstrate the value of the principle. The Mauser pistol, which was exhibited before the society of German engineers at Wurtenberg, is described in the *Zeitschrift des Vereines deutscher Ingenieure* for May 1, in which full details of its construction and operation are given. The general arrangement of the arm is that of the modern magazine guns, on a smaller scale,the principle differrence being in the sliding breech block and firing mechanism, the force of the recoil throwing the block back and at the same time compressing a long spiral spring, which returns it after the cartridge has been fed upward. So long as the trigger is drawn back, the firing continues, while, if the trigger be released, the weapon remains loaded and cocked, ready for action upon the next pull of the finger. The cartridges are fastened together in charges of ten, which can be very quickly loaded into the magazine. The pistol is also made for twenty cartridges at a loading. The rapidity of fire is, of course, the great point, and, it is stated, eighty shots a minute can be succesfully fired. No attempt is made to cool the barrel, as is done in the Maxim gun, but no ill effects appear from this omission. A ten-shot pistol of this type was fired 2,200 times as rapidiy as possible, without being cooled or cleaned, and operated perfectly without apparent injury, while no appreciable wear upon the parts was visible after 10,000 shots. The extent to which such a weapon will be found useful in actual warfare may be questioned, since the waste of ammunition in proportion to the execution is likely to be large, but, considered as a mechanical device, it is certainly a most ingenious production, and possibly may lead to another revision of the small arms of more than one nation, should the recoil principle be demonstrated of sufficient practical value to demand further extension.

Beton Tanks.

THE issue of the *Zeitschr. des Ver. deutscher Ingenieure* for March 13 contains an account of the new water works recently installed in the little town of Calbe, on the Saale. The plant is a small one, the supply being about 900,000 gallons per day, and the only point of especial interest is the tank in the water tower. This tank, which is about 34 feet in diameter by 20 feet deep, is of the Monier type of béton construction, the necessary tensile strength being obtained by imbedding in the wall of the tank a system of round iron rods 10 millimeters in diameter. The bottom of the tank is supported upon a béton dome resting on the masonry walls of the tower, and the whole construction has apparently proved satisfactory. The thickness of the tank walls is about eight inches at the bottom and four inches at the top, and, as the iron nowhere comes in contact with the water, injury from rusting, will it is expected, be avoided.

The Crystallization of Carbon.

THE experiments of Moissan, and his success in producing microscopic crystals of carbon which, technically at least, were entitled to be called artificial diamonds, are well known. We now have further contributions to the subject of the crystallization of carbon by the well-known electro-chemist, Dr. Borchers, who contributes an article to the *Zeitschrift für Elektrochemie* reviewing the past attempts in this direction and describing his own experiments. Moissan worked upon the line of crystallization of fused carbon under immense pressure, while Borchers

attains the same or similar results by maintaining a carbon rod at the high temperature of the electric furnace for considerable time, the surface of the rod showing distinct evidences of crystallization.

The experiments have been carried out upon a small scale only, and, being unable to continue the researches, Dr. Borchers gives a full account of his methods and apparatus, trusting that further investigations may be carried on by those who have powerful currents at their disposal, and opportunity to carry out all the conditions which success demands.

Deep Mine Shafts.

THE depth to which mining shafts have been sunk in various parts of the world is testimony to the industry with which man has constantly sought to win from the earth her mineral treasures, and the list here given, compiled from various sources, and taken from a recent issue of *Stahl und Eisen*, will be of interest.

Belgium:		
Produits mine, Mons,	3930	feet
Vivier shaft, Gilly,	3740	"
Viernoy shaft, Anderlues,	3300	"
Marchienne mine	3120	"
St. Andre shaft, Poirier mine, Charleroi,	3100	"
Germany:		
Kaiser Wilhelm II, Clausthal, Harz,	3020	"
Einigkeit, Lugau, Saxony,	2620	"
Samson, St. Andreasberg, Harz,	2560	"
Monopol mine, Camen, Westphalia,	2535	"
Frieden mine, Oelsnitz, Saxony,	2510	"
Concordia mine, " "	2415	"
Maria mine, Hongen, Rhine Province,	2296	"
Camphausen mine, Saarbrucken,	2299	"
France:		
Montchanin mine, Le Creuzot,	2296	"
Treuil mine, Saint Etienne,	2033	"
Hottinguer shaft, Epinac,	2000	"
Great Britain:		
Pendleton, Manchester,	3470	"
Ashton Moss, "	3350	"
Astley Pit, Dukinfield,	3150	"
Dolcoath mine, Cornwall,	2580	"
Rose Bridge shaft, Wigan,	2490	"
Norway:		
Kongsberg Silver shaft,	1900	"
Austro-Hungary:		
Adalbert, Przbram, Bohemia,	3570	"
Maria, " "	3281	"
Anna, " "	3100	"
Franz Josef " "	2900	"
South Africa:		
Robinson Deep, S. A. R.,	1995	"
Kimberley, Cape Colony,	1265	"
De Beers' mine,	1095	"
United States:		
Red Jacket, Calumet & Hecla, Lake Superior,	4890	"
Tamarack, Lake Superior,	4475	"
Yellow Jacket, Comstock, Nevada,	3120	"
California mine, Colorado,	2260	"
Grass Valley, Idaho,	2180	"
Victoria:		
Lansell's, Bendigo,	3300	"
Lazarus, "	3020	"
Magdala, Stawell,	2410	"

The Henrichenburg Canal Lift.

THE completion of the mechanical canal lift at Henrichenberg calls attention to the favor which this substitute for the old-fashioned lock system is gaining on the continent, and the improvements introduced into this latest installation may lead to its consideration for future use at available locations in the United States. At Henrichenburg, on the canal between Emden and Dortmund, there is a difference of level of more than fifty feet to be overcome, and for this purpose a single tank lift, capable of handling boats of six hundred tons, has been constructed. The great difference between this lift and the well-known hydraulic double lifts at Les Fontinettes in France and at La Louviere in Belgium lies in the fact that the weight of the boat and tank in the Henrichenburg lift is carried by a system of floats, thus avoiding all the difficulties and expense of the great hydraulic cylinders. Beneath the lower slip there are five large wells, each containing a hollow metal tank, or float, and on these floats, by means of lattice piers, the tank is sup-

ported. The depth of the wells is such that, when the tank is at the lower position, the floats are at the bottom, while, when the tank is at the upper level, the piers are just long enough still to keep the floats submerged. The displacement of the five floats being just equal to the weight of tank and its contained water, it is evident that the lift will remain balanced in any position, and the only additional power required is that to overcome friction. The rise and fall are produced by four screws carried on a suitable trestle work and operated by electric motors, and the details of the plan are well worked out. The tank into which the boats are floated and by which they are carried is 28 feet wide, 230 feet long, and 8 feet deep, and the floats by which it is supported are cylinders 27 feet in diameter and 34 feet long. Since a boat always displaces a volume of water equal to its own weight, the counterbalance is the same whether the tank contains a boat or is filled with water; after the balance is once obtained, no further care is necessary on that score. A full account of the work is given in *Schweizerische Bauzeitung* (May 1), with illustrations. A comparison of this plant with the hydraulic cylinder lifts above referred to shows several points of advantage. The hydraulic system involves the use of double tanks, as one is necessary to counterbalance the other, and although double service is gained thereby when two boats are ready at the same time; yet in practice one tank often travels empty, and, where the traffic does not warrant the capacity, yet it must be provided. The heavy strains on the great cylinders, and the careful fitting required, add much to the cost of construction, so that the floating lift can be constructed at much less expense. In point of service there is little or no difference, the time being about three minutes for a lift of fifty feet in either case.

Watertight Bulkheads.

MODERN vessels are supposed to be provided with water-tight bulkheads, dividing the entire vessel into such a number of compartments that at least two of them may be filled with water without causing the ship to sink. If this end is to be attained, it is necessary to consider not only the number of bulkheads, but their location, and this question is not always given the consideration which its importance deserves. In the issues of the *Zeitschr. d. Ver. deutscher Ingenieure* for May 29 and June 5, Herr Middendorf, director of the German Lloyds, discusses the whole subject in a most thorough manner, giving numerous diagrams showing the principles upon which the number and arrangement of the bulkheads should be based. Ever since the sinking of the Elbe, the importance of the question of the disposition of the compartments in vessels has been under investigation in Germany, and the present articles are the result of the theoretical and practical investigations which have been made. It is evident that the filling of compartments near either end of the vessel will disturb the equilibrium to a greater extent than if the leak occurs amidships, as in the former case the level position of the ship will be disturbed to a greater degree, and her seaworthiness proportionally impaired. For this reason it is desirable that the compartments forward and aft should be smaller—*i. e.* the bulkheads closer together—than they need to be in the middle of the vessel. The danger line is, of course, the level of the top of the bulkheads, as, if any pitching or rolling brings this line too low, adjoining compartments will fill, and further submergence result. By a combined analytical and graphical investigation, for which the reader must be referred to the original articles, Herr Middendorf constructs what is called a "bulkhead curve," being a diagram indicating for any given vessel the spacing of bulkheads which will cause only a known disturbance of the danger line for the filling of two adjoining compartments. This investigation assumes, in the first place, that all the compartments are empty of cargo, and that a leak will fill them entirely with water. A subsequent discussion takes into account the influence which the contents of the compartment may have upon the disturbance of equilibrium. When merchandise contained in

casks, or water-tight packages, is to be considered, the quantity of water which the compartment can contain is evidently limited to the space between the packages, while in the engine room the volume of the machinery may be deducted, and for other classes of merchandise proportional values have been computed. Upon these conditions the German Lloyds has formulated a series of rules for the placing of bulkheads which must be applied to vessels seeking its register, and it is believed that the strict observance of these conditions will conduce to the greatest safety with the least possible disturbance to comfort and convenience. The articles of Herr Middendorf should command the consideration of the shipping interests of other nations by reason of the importance of the question, while the scientific manner in which the complex problem has been handled cannot fail to interest engineers in any case.

Car-Heating in Germany.

THE use of steam for warming passenger cars has been under trial on the Prussian State Railways since 1887, and, with various modifications and improvements, it seems to have attained sufficient success to cause it to be considered a permanent method. At a recent meeting of the German Society of Mechanical Engineers, a paper describing the present system used in Prussia was read by Herr Wichert, and published in *Glaser's Annalen* for June 1, and from this we abstract some points of general interest. In the earlier installations, the steam was taken from the locomotive at a comparatively high pressure, —forty to fifty pounds,—and the water of condensation was returned in each car through the steam inlet pipe. This caused much trouble from the interference of the water with the steam, and in long trains there was also the objection that the forward cars were overheated in the effort to obtain sufficient warmth in the rear cars. The amount of warmth in various portions of the train was difficult to regulate, and there were various minor obstacles to be overcome. The improved system possesses two especial differences from the original method; the steam is used at a much lower pressure, and there are in each compartment several radiators of different amounts of heating surface, so that gradations of warmth can be obtained. The steam is delivered by one main, and the water of condensation discharged by another, and the steam from the main may be delivered to all, or to a portion, or to none of the radiating surface in any compartment, without in any way interfering with the circulation in the rest of the train. This permits the use of a regulating lever in each compartment, which may be operated by the passenger himself, a pointer indicating the direction of motion required to increase or decrease the temperature. The radiators are composed of U pipes lying flat under the seats, much the same as in the systems used in the United States, and the details possess no especial peculiarity. A special attendant rides on the train, and controls the general operation of the whole apparatus, it being his duty to have the carriages properly warmed before starting, and to inspect compartments which may have been vacated, to see if they have been left in proper condition as regards warmth. While many of the details of the Prussian system are only adapted for the European system of railway carriages, there are some points worthy of consideration in the United States, especially the idea of a variable quantity of heating surface in the radiators. A slight degree of warmth in spring and fall would often be most acceptable on our trains, when the full radiating surface would furnish an intolerable degree of heat, and there is no good reason why this should not be attainable in some such manner as in the Prussian system.

The Regulation of the Lower Danube.

WE reviewed in the March issue of the magazine the important and difficult work so successfully completed on the lower Danube, by which a continuous waterway has been made available for commerce, and we can now only call attention to a valuable illustrated paper upon the same

subject by the Hungarian councillor, Ernst Wallandt, presented before the general meeting of the Austrian Society of Architects and Engineers, and published in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for May 14 and 21. In addition to a description of the difficulties overcome, the paper contains topographical maps and profiles which enable the magnitude and character of the work to be very clearly understood. Illustrations are also given of the various dredges, submarine drills, floating cranes, etc., by means of which more than 225,000 cubic meters of rock were removed under the difficult rapids, not including the 360,000 cubic meters of excavation in the canal of the Iron Gates. Many interesting details of the submarine work are given in the article, which can be only very briefly noted here. The total length of obstructed river was about fifty-six miles, of which only brief portions were uninterrupted, and in most of this long stretch the rapidity of the current formed a serious impediment to the operations. The boats carrying the rock drills were each provided with four massive feet extending to the river bed, and, by means of powerful steam windlasses, the weight of the boat was thrown upon these as posts, thus relieving the drills from the motion due to the undulation of the water. Various forms of drills were tried, but the bulk of the work was done with the Ingersoll and the Lobnitz rock drills, the total number of holes up to the end of 1896 being about 50,000. Much of the work upon the Iron Gate Canal was done either in shallow water, or within coffer dams drained by centrifugal pumps. It is proposed to use chain towage, with fixed tow chains passing over pocketed chain wheels on the boats, for much of the traffic through the canals, this being especially adapted to contend with the rapid current.

Carbid of Iron.

IN a communication presented to the French Academy (*Comptes Rendus*, April 5) M. Henri Moissan gives the results of his recent experiments in the direct production of carbid of iron in the electric furnace. The operation forms an interesting sequel to the production of artificial diamonds, which, as is well known, M. Moissan produced, on a microscopic scale, several years ago. The principle involved in the production of the iron carbid is that enunciated by MM. Troost and Hautefeuille,—that ozone may be generated at temperatures of 1,300° to 1,400° C., notwithstanding the fact that, when produced at ordinary temperatures, it is readily destroyed by the least accession of heat. After describing in detail the method of experiment and the means employed for purification, M. Moissan sums up as follows: "When pure iron and carbon produced from sugar are raised to a high temperature in the electric furnace and slowly cooled, there is found a very small quantity of combined carbon in the metal. In this manner we may obtain a gray iron, solidifying at about 1,150° C. If the metal, at a temperature of 1,300° to 1,400° is poured into a mould, there is found, after cooling, graphite and a large proportion of combined carbon; this is white iron. Finally, if we cool in water suddenly, iron saturated with carbon at 3,000° C., there is produced in the metal an abundant crystallization, from which we may separate a pure and definitely-crystallized carbid of iron, corresponding to the formula $C Fe_2$. This carbid is identical with that found in steel. . . . These facts may all be explained simply by admitting that the carbid of iron, like ozone and oxid of silver, may be formed at a very high temperature, and then progressively decomposed by a diminution of temperature. Thus we find a considerable quantity in steel, of which the point of fusion is quite high; much less in white iron; and still less in gray iron."

Petroleum Motors.

THE demand for an economical and convenient motor, especially of moderate capacity, has been met by a number of makers of gas and petroleum motors in different parts of Europe; and in the notes from the expositions at Berlin and at Geneva, published in various journals, there are nnmerous descriptions of the latest forms.

Petroleum motors were especially in evidence, and the many designs of simple and convenient engines operated by the internal combustion of petroleum should furnish some impetus to this branch of mechanical engineering in the United States. A series of articles in the *Zeitschrift des Vereines deutscher Ingenieure*, reviewing the exhibits at Berlin and Geneva, gives especial prominence to the variety of petroleum motors there shown, and the simplicity of many of these little engines is noteworthy. The general principles of construction were practically the same in all, the petroleum being drawn in with the air in such a manner as to be not only sprayed, but vaporized by contact with heated surfaces of metal. The mixture of vaporized oil and air is then compressed in the same manner as the charge in a gas engine, and ignited by an incandescent tube. In one form of engine the oil is vaporized in a separate vessel, or gasifier, the heat being supplied by the exhaust gases from the cylinder, and the engine details being practically the same as in a gas engine; but in nearly all cases the oil is supplied and vaporized stroke by stroke. The greatest room for difference of design lies in the construction of the governing device, and the difficulty of obtaining close regulation is probably the principal defect. Although the principle in all the regulators is that of the omission of power strokes until the speed begins to fall, the means by which this is obtained vary, being in some cases a pendulum, and in others a centrifugal governor, sometimes cutting off the oil-supply, sometimes diverting it to a by-pass to be returned for use again. The economy of the engines differs mainly with the size, the larger engines naturally being more economical, and the consumption of petroleum varying from 0.85 pint per h. p. per hour for a 16-h. p. motor to 1.25 pint for a 4-h. p. motor. The efficiency of such engines depends upon several elements, not only the degree of compression and the temperature being involved, but also the perfection of the mixture of the air and combustible, the form and character of the compression space, and the position of the ignition tube, since, if these details are not well arranged, much of the combustible will be discharged unburned. The designs exhibited last year and very fully illustrated not only in the journal above noted, but also in the *Schweizerische Bauzeitung* and in the *Revue de Mécanique*, give the latest practice of the best continental builders, and should be examined thoroughly by American constructors.

Alterations in Manuscripts.

A NEW method of detecting alterations in documents has been devised by M. Bruylants, professor in the University of Louvain, and is described in a recent issue of the *Revue des Sciences*. It is based on the following principle: When a sheet of paper which has been sized and finished is moistened, and then exposed, after thorough drying, to the action of vapor of iodine, the portion which has been moistened assumes a violet tint, while the remaining portion of the surface appears a brownish yellow.

This principle may be used to produce a sympathetic writing, since if we write with water upon the surface of paper treated with ordinary size, the writing will appear in a violet color when the dry paper is exposed to the vapor of iodine. The pale violet upon a yellow ground becomes a deep blue on a pale blue surface, when the paper is again moistened, and the characters disappear altogether under the action of sulphurous acid. When a manuscript is suspected of having been fraudulently retouched or altered, the use of the vapor of iodine will often serve to reveal the nature and extent of the alterations. Those portions which have been rubbed will become brownish in tint, and, when a rubbed surface is moistened after exposure to the iodine, it takes a blue color, varying in intensity according to the duration of the exposure. The outline of the rubbed portions remains perfectly distinct after drying, being paler in tint than the rest of the surface. This action is evidently due to the removal of a portion of the starch contained in the size.

These reactions also appear upon paper which has been entirely moistened and

dried,—as in the case of a letter copied in a press,—but the indications are somewhat less distinct. The process will also reveal the existence of pencil marks erased by rubbing. Apart from any traces of plumbago which may have remained, the path of the pencil-point disturbs the surface of the paper, as would any blunt instrument, and, even when the rubbing has been so carefully performed that it has not removed any portion of the surface of the paper, the marks are made entirely legible when exposed to the iodine vapor. The clearness of all these reactions depends upon the character of the paper, and that which contains the smallest quantity of sizing material will naturally give the least brilliant effects; but in every case the changes above described will appear to a greater or less degree, and the use of the reagent in skilful hands should give material aid in clearing up disputed questions of this nature.

The Purification of Waste Water.

THE question of the pollution of streams by the discharge of waste water from manufacturing establishments is often an important one, both to the community and to the mill-owner, and the fairest solution is often uncertain. In a discussion of the subject in the *Oesterr. Monatschr. f. d. oeff. Baudienst* for May, it is shown that in most cases a simple purification installation, varying in character with the nature of the waste, is found sufficient, as a rule, to meet all the imperative requirements. In many instances sedimentation is all that is necessary, and a settling tank or pool of size proportioned to the magnitude of flow will remove the mechanical impurities. Where the work must proceed continuously, a pair of tanks should be provided, so that alternate cleaning may be done. In some cases disinfection or chemical clarification is necessary, and occasionally a filter plant is required. The author of the article referred to, Chief Engineer Skalda, of Brünn, in Austria, describes a simple form of purification plant used with success in connection with several breweries, sugar refineries, and other manufacturing establishments. The plant consists of a double set of basins, through each section of which the flow of impure water alternately passes. In each series there is first a settling basin of sufficient size to require about an hour for the passage of the flow, the current being guided by deflectors in such a manner as to disturb the settlings as little as possible. This is followed by a clearing basin, in which, by a small addition of milk of lime (0.0017 to 0.002 per cent.) mixed by passage through deflecting partitions, the turbidity is removed; and by a filter for the removal of final impurities.

In the plans shown, a space 70 feet long by 30 feet wide and 11 feet deep is required for a plant capable of treating 2,500 cubic feet of water per day, cleaning being required every 40 days; the water containing 2 per cent. of sedimentary matter. This is a double plant with sluices, enabling one-half to be thrown out of use at a time, to provide for cleaning without interruption.

Acetylene Residues.

WHEN acetylene gas is generated by the action of water upon calcium carbid, the residue is a hydrated lime which is usually thrown away, although it has been suggested that it be used in the manufacture of mortar. A note in the *Comptes Rendus* by M. Chuard, however, has indicated another use for this by-product. It is known that in the production of acetylene a small proportion of ammonia is also generated, and it is found that the production of ammonia continues after the generation of acetylene has ceased, if the mass is kept in a moist condition. It has been proposed, therefore, to use this mass as a fertilizer; M. Chuard finds also that, when applied to vines, it acts to prevent the development of the dread phylloxera. This he attributes to the presence of phosphuretted hydrogen, which, it is known, also appears in the generation of acetylene. M. Chuard even goes so far as to propose for this purpose the preparation of a carbid from lime containing phosphate, and slaking the carbid especially for the purpose of killing the insects; but this is yet to be considered as a practicable scheme.

Electric Train Lighting.

IN the issue of *Glaser's Annalen* for May 15, there is an interesting paper before the German Railway Association, by Dr. Max Büttner, reviewing the progress made in lighting passenger carriages by electricity. The paper is to a certain extent a statement of the claims of electric lighting, as opposed to those of gas and especially of acetylene, these latter methods of illumination having recently been discussed before the association by Dr. Pintsch. Dr. Büttner makes no extravagant claims for electricity, but gives some valuable information as to the experience of a number of railways in various countries, from the earliest, on the Jura-Simplon road in Switzerland, to the present time. The principal batteries in use are those of the Electric Power Storage Company of London, and of the Hagan and the Tudor systems in Germany. The comparisons are made principally with gas lighting; with storage batteries the question of weight is considered as important. In this respect the storage battery shows an advantage, the gross weight of gas tanks of equal lighting efficiency being about 30 per cent. greater; it is needless to say that with gas a lighting efficiency equal to that of electricity is usually not furnished. In regard to the commercial touchstone of cost, Dr. Büttner gives some very interesting diagrams, showing the relative cost per lamp-hour (8 candle power) of electricity and gas. As might be expected, the cost varies with the number of hours per day in which light is used, the fixed charges preponderating for the shorter periods. The difference is much less than would be imagined, and is slightly in favor of electric lighting for the longer runs and of gas for the shorter hours. At an average period of four hours per day, the cost is about the same, being about 3½ pfennigs (0.84 cent) per lamp-hour, assuming that both electricity and gas furnish 8 standard candle power. A diagram showing a comparison between electricity and acetylene is also given, but, as the comparison is not for pure acetylene, but for a mixture of illuminating gas and acetylene, it is not of general interest. Dr. Büttner states that pure acetylene is undoubtedly superior in illuminating power to electricity, but at present he considers the cost too great. The paper is of especial interest in view of the extending use of electricity in different countries. This is especially the case in Switzerland, Sweden, Russia, and Denmark; and, in general, there seems to be a response to the demand for better train-lighting.

Liquefaction of Fluorine.

THE success which has attended the more recent attempts to reduce the former so-called "fixed" gases to the liquid state is progressing steadily, and each success is utilized to assist in the next. MM. Moissan and Dewar have now announced in a note to the French Academy (*Comptes Rendus*, May 31) that they have succeeded in liquefying fluorine, this element having hitherto resisted all attempts. The liquefaction was effected very simply, without the use of pressure above the atmosphere, the agent being the intense cold produced by the evaporation of liquid oxygen. The temperature of liquefied oxygen is about —183° C., which is in itself not quite low enough to cause the fluorine to become liquid; but, when a vacuum was formed above the liquid oxygen, the rapid evaporation lowered the temperature, and the drops of liquid fluorine began to collect, at a temperature estimated to be —185° C. The product was a clear yellow liquid of great mobility, having no action upon glass; as soon as the temperature was permitted to rise, a rapid ebullition of fluorine gas given off. In connection with these experiments an interesting phenomenon was observed. When a current of fluorine gas was passed through liquid oxygen, a flocculent white deposit was formed, which settled at the bottom of the vessel. When this was separated by filtration, it was found to possess the curious property of deflagrating as soon as the temperature began to rise. Until now no compound of fluorine and oxygen has been known to exist.

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American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées. *m.* 31 francs. Paris.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.*. $5. Boston.
Atlantic Monthly. *m.* $4. New York.
Australian Mining Standard. *w.* 30*s.* Sydney.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Comptes Rendus de l'Academie des Sciences. *w.* Paris.
Contemporary Review. *m.* $4.50. London
Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrochemische Zeitschrift. *m.* 18.40 marks. Berlin.
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Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
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Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.

Engineers' Gazette. *m.* 8*s.* London.
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Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Journal. *s-m.* 50 cts. Stanford Univ.
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
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Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
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Garden and Forest. *w.* $4. New York.
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Gas World, The. *w.* 13*s.* London.
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Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
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Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
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Jour. Am. Soc. Naval Engineers. *qr.* $6. Wash.
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Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
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Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the Society of Arts. *w.* London.
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Kansas University Quarterly. *qr.* $2. Lawrence Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
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Le Génie Civil. *w.* 45 fr. Paris.
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Locomotive Engineering. *m.* $2. New York.
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Mining Journal, The. *w.* £1. 8*s.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* fl. 12. Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Moniteur Industriel. *w.* 40 francs. Paris.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
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New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* 24 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
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Railway Press, The. *m.* 7*s.* London.
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Review of Reviews. *m.* $2.50. New York.
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Science. *w.* $5. Lancaster, Pa.
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Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
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Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
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Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
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Trans. Am. Soc. Civil Engineers. *m.* $10. New York
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State's Duty, The. *m.* $1. St. Louis.
Western Electrician. *w.* $3. Chicago
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Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1 50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Lokomotivführer. *m.* 5 marks. Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
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ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

BRICK Building.

Largest Brick Building in the World. The Pension Office at Washington. Illustrated description of a building said to be the best ventilated and most sanitary of all the great federal offices. 1300 w. Brick—June, 1897. No. 13267.

BRICKWORK.

Mole Antonelliana. G. W. Percy. Illustrated detailed description of an example of light construction in brickwork, in the city of Turin, Italy. A brief history of the origin, progress and changing uses of the building. 4200 w. Jour Assn of Engng Soc—May, 1897. No. 13660 C.

BUSINESS Building.

The Modern Business Building. J. Lincoln Steffens. The fifth paper in the series entitled "The Conduct of Great Businesses." Discusses the causes that produced the high building, its dependence on the elevator, its construction, and matters relating. Ill. 11500 w. Scribner's Mag—July, 1897. No. 13653 C.

CANTERBURY.

Canterbury and Its Cathedral. An interesting account of the Cathedral, chapter house cloister, Christchurch gate, and West gate, with brief report of the reopening of the restored chapter house. 2200 w. Ill Car & Build—June 4, 1897. No. 13398 A.

CHURCHES.

The Churches of Poitiers and Caen. Mrs. Schuyler Van Rensselaer. Interesting illustrated description of the ancient churches, with history, legends and study of styles, and other information. 10000 w. Century Mag—July, 1897. No. 13795 D.

CORNICES.

Terra Cotta Cornices for Steel-Skeleton Buildings. W. L. B. Jenney. Examples, with description of types from office buildings. 1300 w. Br Build—June, 1897. No. 13704 C.

DWELLINGS.

Workingmen's Dwellings. (Zur Frage der Arbeiterwohnungen.) Giving an account of the colonies of workingmen's houses in connection with Krupp's steel works, with illustrations of typical houses. 1 Plate, 2500 w. Glückauf—May 29, 1897. No. 13581 B.

FIREPROOF Construction.

An Expert's Opinion of Pittsburgh Fire. Report of S. Albert Reed. Describes the damage and the cause, and lessons learned from this fire. 2500 w. Eng Rec—June 26, 1897. No. 13736.

Fireproof Building Construction in the Pittsburg (Pa.) Fire. The story of the fire, with illustrations and extracts from an article published in the Engineering News, and editorial. 5500 w. Arch & Build—June 12, 1897. No. 13419.

Fireproof Buildings. Editorial on the investigations of fireproof construction being made in the United States, and the importance of having such tests made in England. 2000 w. Builder—May 29, 1897. No. 13351 A.

Fire Protection in Europe, Edwin O. Sachs. The first of a series of contributions intending to record the facts and issues, and furnish an outline of fire protection as it exists to-day. 6500 w. Engng—June 18, 1897. Serial. 1st part. No. 13709 A.

The Recent Fire at Pittsburgh. Peter B. Wight. Description, with illustrations, and discussion of its effect on the fire-resisting construction and material. 6400 w. Br Build—June, 1897. No. 13705 C.

FLOORING.

Tests of the Wearing Qualities of Flooring Materials. A valuable series of tests to determine the relative durability of various flooring materials, with results, and valuable diagram. 600 w. Sci Am—July 3, 1897. No. 13769.

Tests of Expanded Metal Floor Construction. Describes test and gives report of George Hill. Ill. 900 w. Eng Rec—June 26, 1897. No. 13735.

ITALIAN Renaissance.

A Revised View of Italian Renaissance Architecture. Editorial review of book by William J. Anderson, architect, director of architecture and lecturer at the Glasgow School of Art. 2700 w. Builder—June 12, 1897. No. 13635 A.

LEICESTER.

The Architecture of Our Large Provincial Towns. Illustrated description of the structures in Leicester, with some historical matters of interest. 7500 w. Builder—June 5, 1897. No. 13399 A.

LIBRARY.

The New University Library at Princeton. Andrew F. West. Illustrated description. 600 w. Harper's Wk—June 12, 1897. No 13339.

Preliminary Competition for the New York Library Building. Information regarding the proposed building and the committee's manner of obtaining plans. 1600 w. Arch & Build—June 5, 1897. No. 13289.

OBSERVATORY.

The Chamberlin Observatory, Denver. Illustrated description of building and equipment. 2500 w. Engng—May 28, 1897. No. 13347 A.

The Mont-Blanc Observatory. From *La Nature*. Brief illustrated description of an interesting construction. 1000 w. Sci Am Sup—June 12, 1897. No. 13373.

REMODELING.

The Royal Infirmary, Glasgow. A correspondent of the *Glasgow Herald* presents a scheme, considering the question in relation to its surroundings. 1600 w. Arch, Lond—June 11, 1897. No. 13638 A.

SCHOOL-HOUSES.

Site, Construction and Furnishing of School-Houses. Excellent recommendations and regulations for "lighting, heating, ventilating and other sanitary arrangements" of school-houses, issued by the State Board of Health of Vermont. 1200 w. San—June, 1897. No. 13450 D.

STEEL-SKELETON Building.

The Architectural Relations of the Steel-Skeleton Building. F. H. Kimball. The problems confronted in the creation of a high building, and the order in which they must be studied. Ill. 3300 w. Eng Mag—July, 1897. No. 13808 B.

STRASBURG.

The Romanesque Style in Strasburg Cathedral. (Das Strasburger Münster Romanischen Stiles.) An account of the Romanesque details to be found in the earlier portions of Strasburg Cathedral, with plans of the structure at various dates. An interesting contribution to architectural history. 6000 w. Oesterr Monatschr f d Oeffent Baudienst—June, 1897. No. 13529 D.

TEMPORARY Structures.

The Paris Fire and the Building of Temporary Structures, H. Heathcote Statham. Showing how official control and inspection should guard against fire. Ill. 3600 w. Eng Mag—July, 1897. No. 13804 B.

THEATRE.

The "Westen" Theatre in Berlin. (Das Theater des Westens in Berlin.) Illustrated description of this handsome new theatre in the fashionable quarter of Berlin. 1 Plate, 2000 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13523 D.

HEATING AND VENTILATION.

AIR Ducts.

The Proper Location of Air Ducts. David B. Dick. From a paper on Ventilation, read before the Toronto San. Assn. Gives experiments made to test the temperature at various heights in rooms, and discusses the problem, concluding that the warm air should be admitted at the floor, and the outlet be at the ceiling. 1500 w. San Plumb—June 1, 1897. No. 13270.

BLOWING Fans.

Tests of Blowing Fans Under Different Conditions and of Different Makes. R. C. Carpenter. Read at semi-annual meeting of Am. Soc. of Heating and Ventilating Engs. A talk on investigations made at Cornell Univ., and the results. 4200 w. Heat & Ven—June 15, 1897. No. 13745.

CAR Heating.

See Railroad Affairs, Maintenance of Equipment.

EFFICIENCY.

Efficiency of Heating Systems as Affected by the Removal of Air from the Radiators and Consequent Reduction of Pressure. H. A. Joslin. Read at semi-annual meeting of Am. Soc. of Heating and Ventilating Engs. Data obtained from tests made upon plants. Also discussion. 2800 w. Heat & Ven—June 15, 1897. No. 13746.

ELECTRICAL Heating.

Construction of Electrical Heating Apparatus. R. Van Rensselaer Sill. Read at semi-annual meeting of the Am. Soc. of Heating and Ventilating Engs. The writer points out what he believes to be the mistakes in the construction of the electric heater and shows how they may be remedied. Also discussion. 1200 w. Heat & Ven—June 15, 1897. No. 13744.

FACTORY.

Heating and Ventilating a Five-story Factory. Illustrated detailed description of the system used in the White Dental Factory, Philadelphia, Pa. 1300 w. Eng Rec—June 19, 1897. No. 13499.

FURNACE Heating.

Furnace Heating. Advocates the hot-air furnace for heating church buildings. 1200 w. Dom Engng—June, 1897. No. 13442 C.

HOUSE Heating Boilers.

The Relation that Should Exist Between the Steam and Water Ratings of House Heating Boilers. A. C. Mott. Read at semi-annual meeting of the Am. Soc. of Heating and Ventilating Engs. A discussion of the subject with the aim of drawing out valuable discussion. 2000 w. Heat & Ven—June 15, 1897. No. 13743.

SANITATION.

See Plumbing and Gas Fitting.

SHOP Heating.

Heating of the Shops of the Westinghouse Machine Company. The exhaust steam from the engines is used to heat the building with a blower and duct system. Illustrated description. 1400 w. Eng Rec—June 26, 1897. No. 13737.

SIEGEL-COOPER Co.'s Store.

Heating and Ventilation of the Siegel-Cooper Co.'s "Big Store." Illustrated description. 1100 w. Heat & Ven—June 15, 1897. No. 13742.

SOCIETY Meeting.

Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers. An account of the first semi-annual meeting with president's address, abstracts of papers read, business, etc. 9000 w. Met Work—June 26, 1897. No. 13687.

STEAM Heating.

Circulation of Steam for Heating Purposes at or below the Pressure of the Atmosphere. Reginald Pelham Bolton. A study of the internal conditions of steam circulation and heating, with a statement of the requirements for effective steam heating systems. 4300 w. Dom Engng—June, 1897. No. 13443 C.

New York Steam Company's Plant. Brief illustrated description. 1200 w. Heat & Ven—June 15, 1897. No. 13741.

On Some Dangers Attending the Use of Steam Pipes. A. L. Steavenson. Considers thickness of steam pipes, the fact that they may be the cause of fire, water rams, &c. 2000 w. Ir & Coal Trds Rev—June 11, 1897. No. 13630 A.

Pipe Covering as an Investment. C. H. Lietze. Calculations of the loss from bare pipes, and of the percentage to be saved by covering. 1500 w. Heat & Ven—June 15, 1897. No. 13747.

WOODBRIDGE Building.

Heating and Lighting of the Woodbridge Building, New York city. Illustrated detailed description. 2000 w. Eng Rec—June 5, 1897. No. 13275.

LANDSCAPE GARDENING.

GARDENING Design.

Doing Too Much. Editorial commenting on the mistakes made through ignorance, and citing examples illustrating intelligent treatment. 1700 w. Gar & For—June 16, 1897. No. 13440.

PARKS.

The Park System of Greater Boston. Editorial

on information from the lately issued report of the Metropolitan Park Commission. 1100 w. Gar & For—June 23, 1897. No. 13645.

Natural Beauty in Urban Parks. Editorial on the restful and helpful effect upon city dwellers, of natural scenery; the duty to protect such places and keep them for the good of the people; and a protest against the erection of buildings in objectionable places in Bronx Park. 1300 w. Gar & For—June 30, 1897. No. 13774.

PLUMBING AND GASFITTING.

DRAINAGE.

Details in House Drainage and Plumbers' Work. J. Kemsley. Reports cases where inspection showed that lack of attention to details caused serious illness and much trouble. 1800 w. San Rec—May 28, 1897. Serial. 1st part. No 13300 A.

GRAVITY.

The Law of Gravity in Plumbing Work. N. Y. P. Remarks on the effect of the laws of the universe, especially of gravity as related to plumbing. 1700 w. San Plumb—June 1, 1897. No. 13269.

MASTER Plumbers.

The National Association of Master Plumbers, U. S. A. Part first consists of introductory remarks and an account of the creation, constitution, progress, &c., of the association. 5500 w. San Plumb—June 15, 1897. No. 13441.

SANITATION.

Plumbing, Heating and Ventilating a Modern Residence. Illustrated description of many excellent features as carried out in a residence at Wilkes-Barre, Penna. 2800 w. Met Work—June 5, 1897. No. 13266.

Plumbing and Sanitary Work. S. S. Hellyer. Read before the Architectural Assn., London, Part first discusses improvements in valve-closets, water supply, service pipes, &c. 4800 w. Brit Arch—May 28, 1897. No. 13301 A.

MISCELLANY.

ACOUSTICS.

Photographing the Koenig Manometric Flames. (Photographie des Flammes de Koenig.) A description of the method used to obtain permanent records of acoustic phenomena. Acetylene was used in the manometric burner and the vibrations photographed. 1000 w. Comptes Rendus —April 12, 1897. No. 13551 D.

ARCHES.

Strains in Arches. Joseph Marshall. The first of three articles giving the writer's theory regarding "Thrusts and Strains in Arches." 1800 w. Br Build—June, 1897. Serial. 1st part. No. 13706 C.

BENDING Moment.

Bending Moment Due to Concentrated Loads. H. Szlapka. Mathematical demonstration of method used by the author. 500 w. Eng News—June 24, 1897. No. 13686.

BUILDING.

Building and Building Material During the Reign of Queen Victoria. A review of the transformations in building material which have marked the reign. 4300 w. Ill Car & Build—June 18, 1897. No. 13688 A.

CATHEDRAL.

St. Paul's Cathedral. Part first discusses the relation of bishops and other clerics to architects and the preparation of the site, with its difficulties. Ill. 2500 w. Arch, Lond—June 18, 1897. Serial. 1st part. No. 13708 A.

CHIMNEY.

Straightening a Leaning Chimney. O. L. E. Weber. Describes a case where the straightening was effected by sawing the mortar joints. 1300 w. Technic—1897. No. 13757 D.

CHURCHES.

The Position of Choir and Organ in Churches. A letter from the Bishop of Chester to the London *Times*, with editorial, giving many opinions of noted architects and organists. 4200 w. Arch, Lond—June 11, 1897. No. 13637 A.

COLLAPSE of Building.

Fatal Collapse of Part of a Cast-Iron Column Building in New York. Description, with illustrations, of the collapse of a five-story factory building, corner of 51st street and 12th ave., with editorial. 3900 w. Eng Rec—June 12, 1897. No. 13436.

The Failure of the Brown Soap Factory Building in New York City. Discusses the collapse of a portion of the building at 12th Ave. and 51st street, with illustrated description of the structure, and the possible causes of the failure. 3500 w. Eng News—June 17, 1897. No. 13486.

DERRICK.

A Compact Derrick for Skeleton Buildings. An illustrated description of a derrick used for over two years on both high and heavy iron erection. It has many advantages, is very light and quickly moved, raised and refastened and adjusted. 700 w. Eng Rec—June 5, 1897. No. 13274.

FOUNTAIN.

The Hercules Fountain at Augsburg. (Der Hercules Brunnen in Augsburg.) Description and illustration of the handsome fountain designed by Adrian de Vries and built in 1602. 1 Plate, 1500 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13522 D.

FREE Homes.

Free Homes for the People. Stanley Boulter. A scheme by which English municipalities shall be empowered to advance to the working classes the necessary money to purchase their houses, and that the advances shall be repaid, by instalments, instead of rent. 6500 w. Ill Car & Build—June 11, 1897. No. 13642 A.

LADDERS.

See Mining and Metallurgy. Miscellany.

ROCK Cutting.

Rock-Cut Tombs, Temples and Habitations. Cyrus K. Porter. Interesting description of ancient architecture. 5800 w. Stone—June, 1897. No. 13475 C.

SUBURBAN Settlement.

"Homewood." A Model Suburban Settlement. E. R. L. Gould. Describes a scheme for providing pleasant homes for the working classes, giving many plans of the houses, illustrations of the architecture, and general information. 3000 w. Am Rev of Revs—July, 1897. No. 13797 C.

TERRA-COTTA.

Suggestions for the Manufacture of Hollow Building Blocks. Robert Kunstman. Consid-

ers the selection of raw material, preparing the clay, machinery for making the blocks, drying and burning, and general arrangement of the factory. Ill. 2200 w. Brick—June, 1897. No. 13268.

TRANSATLANTIC.

Transatlantic Notes. Arthur Lee. Interesting notes on architectural and related subjects. 2400 w. Stone—June, 1897. No. 13474 C.

CIVIL ENGINEERING.

BRIDGES.

ALPINE Roads.

Concerning Roads in the Tyrolese Alps. Executed, Projected, and Desired. (Ueber ausgeführte, projectirte, und wünschenswerthe Tiroler Alpenbahnen.) A detailed account of the existing roads, dealing mainly with costs and financial results, together with a similar discussion of proposed constructions. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—May 28, June 4, 1897. No. 13516 E.

ARCHES.

See same title under Architecture and Building, Miscellany.

BEAMS.

The Theory of Reinforced Béton Beams. (Zur Theorie der verstärkten Béton platte.) An elaborate mathematical and graphical discussion of the principles involved in the Monier system of concrete reinforced by metal. Two articles. 8000 w. Zeitchr d Oesterr Ing u Arch Ver—May 28 & June 4, 1897. No. 13517 E.

DEFLECTION.

Apparatus for Maxima and Minima Measurement of Deflections. (Mesure des Fléches, Appareil á Maxima et Minima.) Illustrating the standard apparatus for measuring and recording girder deflections as used by the department of *Ponts et Chaussées*. 2500 w. Le Génie Moderne—May 15, 1897. No. 13536 B.

EUROPEAN Bridges.

Esthetic Design in European Bridges. Robert Grimshaw. Illustrations and brief descriptions of some artistic work in this line. 1500 w. Eng News—June 17, 1897. No. 13485.

LATTICE Girders.

Wooden Lattice Bridges in Galicia. (Hölzerne Gitterbrücken in Galizien.) Mainly descriptive, showing some recent structures with spans from 80 to 145 feet. 1 Plate. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—June 4,1897. No. 13519 B.

RIVER Bridge.

Construction of Little Calumet River Bridge. Benjamin Douglas. Description with elevation of abutments and pier. 3000 w. Technic—1897. No. 13758 D.

TESTS.

Tests of Bridge Details. D. Y. Dimon. Abstracted from a thesis prepared for the degree of C. E. in 1896. The details tested were sleeve nuts, loop floor beam hangers or stirrups, welded loop eyes such as are used on light counter rods, bent eyes as used for lateral connections. Results are given. 800 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13672 D.

VIADUCT.

See Street and Electric Railways.

VICTORIA Bridge.

The Victoria Bridge Over the River Dee. Detailed illustrations and views of this bridge at Queensferry, with description. 1700 w. Engng—June 11, 1897. No. 13609 A.

CANALS, RIVERS AND HARBORS.

CANAL Lift.

The Canal Lift at Henrichenburg. (Das Schiffshebewerk bei Henrichenburg.) A lift of over 50 feet for canal boats of 600 tons displacement, the weight being counter balanced by floats and the lifting effected by screws. 2000 w. Schweizerische Bauzeitung—May 1, 1897. No. 13533 B.

DANUBE.

Soundings in the Danube. (Sondierverfahren an der Donau.) An account of the soundings made near Kritzendorf, to determine the volume of discharge. The so-called "cross" method was used, with diagonal intersecting lines, the distances being determined by the Reichenbach telemeter. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13525 D.

The Regulation of the Lower Danube. (Die Regulirungsarbeiten an der unteren Donau und deren Resultate.) A fully illustrated account of the canalization of the Iron Gates and the other improvements which have made the lower Danube navigable. Two articles. 10000 w. Zeitscher d Oesterr Ing u Arch Ver—May 14 & 21, 1897. No. 13514 E.

FLOODS.

Construction of the Most Recent Flood-Prevention Works in Eastbourne. R. M. Gloyne. Abstract of paper read before the Incorporated Association of Municipal and County Engineers, England. Describes works being executed for the purpose of obviating the periodical flooding to which parts of the town have been subject in times of heavy rainfall. Discussion. 2500 w. Builder—June 12, 1897. No. 13636 A.

The Mississippi Flood of 1897. William Starling. Discusses the sources of the flood, the effect of the new levees upon the flood height, storms, channel erosion, strengthening the levees, breaking of the levees, &c., &c. Ill. 12800 w. Eng News—July 1, 1897. No. 13818.

HOOGHLY River.

The River Hooghly, M. B. The improvement of this river, on which stands the metropolis of India. 2500 w. Ind Engng—May 22, 1897. Serial. 1st part. No. 13644 D.

RHINE.

The Regulation of the Rhine. (Die Rhein-Regulierung.) An account of the proposed regulation of the Rhine at its discharge into the Lake of Constance in order to avoid the frequent overflows. The cost is estimated at over

$3,000,000. 4500 w. and topographical map. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13520 D.

SAULT ST. MARIE.

The Busiest Canal in the World. William V. Kibbee. Describing St. Mary's Falls canal. Ill. 2900 w. Eng Mag—July, 1897. No. 13812 B.

SEINE.

Dangers to Navigation at the Mouth of the Seine. (Les Dangers de la Navigation à l'Embouchure de la Seine.) Describing the shifting of the bar, and the variations in the channel, with suggestions as to the remedy; with hydrographic charts 1 plate 3000 w. La Revue Technique—May 10, 1897. No. 13540 D.

IRRIGATION.

ARID Regions.

Their Currents Turned Awry. H. A. Crafts. Describes the modes of storing water for irrigation, and gives an illustrated account of the diversion of water from the head of the Big Laramie River to the Cache la Poudre River. 1600 w. Harper's Wk—June 12, 1897. No. 13338.

NORTH-WEST Territories.

Irrigation in the Northwest Territories. William Pearce. A general talk on the benefits of irrigation and the advantage to be derived from its use in all localities. 2000 w. Can Eng—June, 1897. No. 13280.

PRACTICAL Points.

Some Practical Points in Irrigation Engineering. R. C. Gemmell. Hints to the young engineer regarding irrigation surveys and construction 4500 w. Tecnnic—1897. No. 13762 D.

MISCELLANY.

BENDING Moment.

See Architecture and Building. Miscellany.

BLACKWALL Tunnel.

The Blackwall Tunnel Beneath the Thames. Illustrated detailed description with information regarding cost, machinery, &c. 7000 w. Sci Am Sup—July 3, 1897. No. 13770.

The Opening of the Blackwall Tunnel. Reviews the history of the project. 8000 w. Trans—May 28, 1897. No. 13298 A.

CEMENT.

The New Normal Cement of the Hungarian Engineering Society. (Die neuen Cement—Normalien des Ungarischen Ingenieur—und Architekten-Vereines.) An account of the standard cement adopted by the society, giving the mesh of screens, the proportion of mixture, and the tests which must be sustained. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 28, 1897. No. 13518 B.

See "Slag," under Mining and Metallurgy, Iron and Steel.

CONFERENCE.

The Institution of Civil Engineers. Report of the London conference, with abstracts of papers read, and discussions. 31500 w. Eng, Lond—May 28, 1897. No. 13318 A.

ENGINEER.

The Engineer and the National Society. Benjamin Morgan Harrod. Extracts from the address at the annual convention at Quebec, with editorial. Calls attention to some of the relations of a national society to the profession. 3500 w. R R Gaz—July 2, 1897. No. 13815.

HYDRODYNAMICS.

The Gradual Variations in the Flow of Water in Channels of Large Section. (Écoulement graduellment Varié des liquides dans les lits à grande section.) An elaborate mathematical treatment of the subject by M. Boussinesq, giving the derivation of the fundamental equations. 3000 w. Comptes Rendus—May 31, 1897. No. 13556 D.

HYDROGRAPHIC Surveys.

Some Methods of Making Hydrographic Surveys. Charles T. Dixon. Describes methods used on the Detroit and St. Mary's rivers for determining the contour of the bottom of a stream or channel, enabling the amounts of material above any required depth to be computed. 4000 w. Technic—1897. No. 13756 D.

MAGNETIC Surveys.

The Engineering Value of Magnetic Surveys. William S. Aldrich. Abstract of paper presented at the annual meeting. Matters of interest and importance relating to the bearing of magnetic observations on engineering development. 1000 w. Jour Assn of Engng Soc—May, 1897. No. 13661 C.

PLANIMETER.

See Mechanical Engineering.

PUZZOLANA.

Puzzolana and its Practical Use. Josef Zervas. Information regarding one of the oldest materials used for making mortar, especially hydraulic mortars. 4200 w. Sch of Mines Quar—April, 1897. No. 13454 D.

ROADS.

Good Roads. Daniel B. Luten. A criticism of American methods of road improvement, with reference to the system in France, and discussion of cost. 1800 w. Technic—1897. No. 13764 D.

SCHOOLS.

See same title under Mechanical Engineering.

SURVEYING.

The Comparison of Measurements by Least Squares. (Ueber Ausgleichung von Linienverbindungen bei Kleinmessungen.) Giving working examples of the determination of the probable error in a system of measurements by the method of least squares, without the necessity of geometrical construction. 7500 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13524 D.

TUNNEL.

Tunnel Roof-Shield Used in the Boston Subway. Illustrated description of the form of shield used. 1500 w. Eng News—June 24, 1897. No. 13682.

TRANSCONTINENTAL Arc.

The Transcontinental Arc from Cape May to San Francisco. E. D. Preston. Considers the determination, accuracy and usefulness. 5800 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13666 D.

WINDMILLS.

See same title under Mechanical Engineering, Power and Transmission.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BRITISH Guiana.

Tariff of British Guiana. A copy of the tariff ordinance for the year 1897-98; also, a statement taken from the *Argosy*, showing the increase and decrease on different articles as compared with last year. 4500 w. Cons Repts—June, 1897. No. 13652 D.

BRITISH Trade.

Do Foreign Annexations Injure British Trade? Henry Birchenough. Examines the British trade with foreign colonies, showing that Gt. Britain succeeds in carrying on a valuable export trade with the colonies of foreign powers, and stating the advantages of the country over her rivals. 4500 w. Nineteenth Cent—June, 1897. No. 13394 D.

BUSINESS Conditions.

The State of Trade. An analysis of business conditions based on interviews with manufacturers and wholesale merchants at more than fifty cities, showing moderate improvement at western centers, with less evidence of gain in the east. 2500 w. Bradstreet's—June 26, 1897. No. 13689.

CHINA.

Commercial Trend of China. Thomas R. Jernigan. Discusses some of the efforts of European nations to enlarge their trade relations, and gives statistics helpful to the business man in forming an opinion as to the direction in which the volume of China's trade is moving. 2200 w. N Am Rev—July, 1897. No. 13755 D.

FAILURES.

Business Failures Classified. Enumeration of the total number of concerns engaged in business in thirty-seven lines of trade, and the number of failures in 173 lines of business in 1894, 1895, and 1896. 5000 w. Bradstreet's—June 5, 1897. No. 13281.

Business Failures for Six Months. Report and tables of comparison. The past six months not as favorable as was anticipated. 1400 w. Bradstreet's—July 3, 1897. No. 13821.

FOREIGN Commerce.

New York's Decreasing Share in Our Foreign Commerce. Showing that all branches of export business of New York are threatened. 1200 w. Bradstreet's—June 19, 1897. No. 13601.

GERMANY.

Trade and Training in Germany. Extracts from and comments upon a recent discussion of this subject by Sir Philip Magnus, in the London *National Review*. 5000 w. Gunton's Mag—July, 1897. No. 13801 C.

JAPAN.

The Encouragement of Industry in Japan. Discusses three bills submitted to the Diet this session which have special interest for foreigners. 1600 w. Bd of Trd Jour—June, 1897. No. 13695 A.

Yokohama Chamber of Commerce. A few remarks on some of the points mentioned in the annual report of this organization. 1600 w. Engng—June 4, 1897. No. 13409 A.

MANUFACTURED Exports.

British *versus* American Manfactured Productions. Editorial comment on the increase of American productions, the advantages possessed by Americans, and the effect upon British mechanical industries. 1800 w. Ir & Coal Trds Rev—June 11, 1897. No. 13631 A.

PRICES.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle, and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from Jan. 1, 1893, to June 1, 1897, Covering the Period of Recent Extreme Depression. Table. Bradstreet's—June 12, 1897. No. 13395.

PROTECTION.

Philosophy of Protection. Considers the two cardinal elements of tariff legislation to require an intelligible understanding of the purpose of protection and a knowledge of the incidence of tariff taxation, and discusses these points. 3000 w. Gunton's Mag—July, 1897. No. 13798 C.

RUBBER Goods.

Meeting of Mechanical-Goods Makers. A conference to bring about general good feeling and discuss the conditions of this industry, with the view of regulating prices. Also editorial. 2000 w. Ind Rub Wld—June 10, 1897. No. 13621 D.

SOUTH AMERICA.

How to Get South American Trade. John A. Johnson. Presents mainly the necessity of better means of communication. Taken from a pamphlet published by the writer. 1800 w. Ir Trd Rev—June 24, 1897. No. 13679.

TARIFF.

Customs Tariff of Russia. Consular report of duties imposed by Russia upon some of the principal articles exported by the United States. 2500 w. Cons Repts—June, 1897. No. 13-648 D.

New Customs Tariff of Canada. A copy of the resolutions proposed in the Committee of Ways and Means of the Canadian House of Commons relative to duties of customs, excise, &c. 3700 w. Bd of Trd Jour—June, 1897. No. 13696 A.

Tariff Changes and Customs Regulations. Netherlands—Curacoa, France, Tunis, Portugal, Italy, Roumania, United States of Colombia, British India, St. Christopher—Nevis, Montserrat, Queensland. 3300 w. Bd of Trd Jour—June, 1897. No. 13697 A.

The Tariff Revolution in Canada. Hartley Withers. Discusses the recent changes in the Canadian tariff, chiefly from the commercial standpoint. 2500 w. Bankers' Mag, Lond—June, 1897. No. 13344 A.

TRADE Relations.

The South and the West. John A. Smith. Extracts from an address at Kansas City giving information and suggestions of practical value in the development of closer trade relations. 3000 w. Tradesman—June 15, 1897. No. 13-608.

CURRENCY AND FINANCE.

COINAGE Bill.
Text of the Japanese Coinage Bill. A copy of the bill as translated and published by the *Japan Herald*. 1000 w. Cons Repts—June, 1897. No. 13651 D.

GOLD Standard.
The Gold Standard in Japan. A copy of the formal statement made by Count Matsukata, the Premier, before the Japanese Diet, as to the plan suggested by the cabinet for placing the circulation on a gold basis. 4500 w. Cons Repts—June, 1897. No. 13650 D.

The Greenback and the Gold Standard. Marriott Brosius. Concludes that to deprive the government of the means of maintaining gold payments, and preserving the parity of all our money, and to relegate these functions to private banking institutions would be full of peril. 3300 w. N Am Rev—July, 1897. No. 13754 D.

JAPAN.
Japan's Monetary Somersault. W. R. Lawson. A lengthy discussion of monetary affairs in Japan, especially the gold standard scheme which has recently become a law. 5300 w. Bankers' Mag. Lond—June, 1897. No. 13343 A.

SAVINGS Bank.
The Savings Bank as a Public School of Primary Economic Instruction. William L. Trenholm. Address delivered at the annual meeting of the Savings Banks' Assn. of the State of New York. The necessity of educating the masses in elementary economics. 3000 w. Bank's Mag, N Y—June, 1897. No. 13452 D.

SILVER.
Silver and Prices: The Economic Drain from Debtor Nations. Moreton Frewen. An interesting discussion of the problem of the future exchange value of money—or "how the white man with the yellow money is to meet the competition of the yellow man with the white money." Discussion follows. 7500 w. Jour Soc of Arts—May 28, 1897. No. 13352 A.

LABOR.

AMERICAN Shipping.
See Marine Engineering.

IMMIGRATION.
The Immigration Question. J. H. Senner. Recommends the placing of the distribution of settlers and laborers under the responsible management of a National Land and Labor Clearing House; to exclude all undesirable immigrants and at the same time see that the most desirable are properly distributed over the country. 5400 w. An Am Acad—July, 1897. No. 13825 G.

LABOR.
Labor Problems of To-day. Part first consists of introductory remarks aiming to present existing conditions. 2500 w. Ir & Coal Trds Rev—June 4, 1897. Serial. 1st part. No. 13403 A.

STRIKES.
Strikes in Japan. Fusataro Takano. A rather pessimistic view of the present labor conditions in Japan, with editorial comment. 2200 w. Gunton's Mag—July, 1897. No. 13800 C.

WORKMEN'S Bill.
The Economic Effects of the Workmen's Compensation Bill. Emerson Bainbridge. Aims to show the effect of the bill upon those who are supposed to be benefitted, on those who are asked to pay the costs, and upon the general trade. 1800 w. Ir & Coal Trds Rev—May 28, 1897. No. 13354 A.

MISCELLANY.

CHEAPNESS.
Is Cheapness an Evil? George Allen White. The subject is discussed from one standpoint by the writer, and replied to editorially from another point of view. 2200 w. Gunton's Mag—July, 1897. No. 13802 C.

PATENT System.
The Patent System as a Factor in National Development. William C. Dodge. Showing how invention and production have increased under the United States patent laws. 4200 w. Eng Mag—July, 1897. No. 13807 B.

PRODUCTION.
Governments and Co-operative Production. Editorial discussion of the co-operative principle and its difficulties, based upon the report of D. F. Schloss to the Labor Department of the Board of Trade. 2500 w. Engng—June 18, 1897. No. 13710 A.

WEALTH Distribution.
Dangers of a Wrong Point of View. Discusses a book published by Dr. Charles B. Spohr on "The Present Distribution of Wealth in the United States," criticising it as a violent misrepresentation arising from a wrong point of view. 3500 w. Gunton's Mag—July, 1897. No. 13799 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

CONSERVATION of Energy.
The Principle of the Conservation of Energy in Electrochemistry. (Das Prinzip der Erhaltung der Energie in der Elektrochemie.) A scholarly investigation of an important phase of the great problem of the conservation of the physical forces. 4000 w. Deutsche Zeitschrf Elektrotechnik—April, 1897. No. 13586 B.

ELECTROLYSIS.
Notes on the Electrolysis of the Alkaline Bromides and Fluorides. (Beiträge Zur Elektrolyse der Alkali-Bromide und Fluoride.) Showing the arrangement of apparatus and giving the details of the reactions. 4000 w. Zeitschr f Elektrochemie—May 5, 1897. No. 13590 B.

The Electrolysis of Mixtures. (Zur Elektrolyse von Gemischen.) An examination of the chemical theory and practice of the electrolysis of mixtures according to Hittorf's theory. 7500 w. Zeitschr f Elektrochemie—May 20, 1897. No. 13592 B.

The Electrolytic Reduction of Nitro-Benzole. (Elektrolytische Reduktionen des Nitro Benzols.) Giving details of solutions used and proper currents to effect the desired reduction. 2500 w. Zeitschr f Elektrochemie—May 5, 1897. No. 13589 B.

The Influence of Time upon the Cathode Action in Electrolysis of Copper Solutions. (Ueber den Einfluss der Zeit auf den Kathoden Vorgang bei Elektrolyse der Kupfersulfatlösung.) Giving graphical records of a number of experimental investigations. 4000 w. Zeitschr f Elektrochemie—June 5, 1897. No. 13593 B.

SODIUM Peroxid.

Making Sodium Peroxid at Niagara. Orrin E. Dunlap. Describes the electrical equipment of the Niagara Electro-Chemical Co. Ill. 500 w. Elec Eng—June 23, 1897. No. 13714.

LIGHTING.

ACCUMULATORS.

Accumulators—Their Application to Central Station Lighting and Power. W. A. Johnson. Read before the Can. Elec. Assn. Presents the advantages and adaptability of accumulators, and the cost. 1800 w. Can Elec News—June, 1897. No. 13484.

ARC Lamp.

Progress of the Enclosed Arc Lamp. Louis B. Marks. The development, progress and commercial success. 900 w. Elec Wld—June 5, 1897. No. 13326.

The Enclosed Arc Lamp. E. L. Nichols. Read before the Cornell Electrical Soc. Considers some of the peculiarities of this lamp, its advantages, tests, &c. 1800 w. Sib Jour of Engng—June, 1897. No. 13424 C.

ARC Lighting.

Recent Progress in Arc Lighting. Elihu Thomson. Abstract of a paper read before the Niagara Falls convention of the National Electric Light Assn. The writer thinks the immediate future of the series arc lighting system appears to be in the development of large dynamos. Considers pulsating currents, constant potential arc work, inclosed arcs, results of tests, &c. 5500 w. Elec Wld—June 12, 1897. No. 13447.

BRIGHTON, England.

The Electric Lighting of Brighton, England. Fred Bathurst. A brief illustrated description of the electric lighting features of this popular seaside resort. 5700 w. Am Elect'n—June, 1897. No. 13384 C.

CONVENTION.

National Electric Light Association. Report of the proceedings of the convention held at Niagara Falls, June 8, 9, and 10, 1897. 6000 w. Elec Wld—June 12, 1897. No. 13448.

DAY Load.

A Profitable Day Load for a Large Central Station. C. H. Wilmerding. Examines the subject from various points of view, and suggests a method for establishing rates. 2000 w. Elec Wld—June 5, 1897. No. 13327.

Day Loads for Central Stations, and How to Increase Them. J. A. Kammerer. Read before Can. Elec. Assn. States the points that commend themselves from a lighting standpoint. 1800 w. Can Elec News—June, 1897. No. 13483.

The Daylight-Work of Central Stations. Abstract of a paper read before the convention of the National Electric Light Assn., at Niagara Falls, by Thomas Commerford. Traces the development of the industry, and the improvement in the last ten years. 1400 w. Elec Wld—June 12, 1897. No. 13444.

ELECTRICAL Equipment.

Electrical Equipment of a Model Commercial Building. Illustrated detailed description of the electrical equipment of the Silversmiths' building in Chicago. 2200 w. W Elec—June 12, 1897. No. 13416.

HOTEL Cecil.

The Electric Plant at the Hotel Cecil. Illustrated description of the electric lighting arrangements, with particulars of the costs of production for various months. 2800 w. Elec Eng, Lond—June 4, 1897. No. 13396 A.

INCANDESCENT Lamps.

High and Low Voltage Incandescent Lamp. John W. Howell. Presents the advantages of high voltage lamps, and the difficulties to be overcome in the manufacture of the lamps. 1500 w. Elec Wld—June 5, 1897. No. 13323.

Report of Committee on Standard Candlepower of Incandescent Lamps. Presented at the National Electric Light Assn. convention at Niagara Falls. Work of the committee with recommendations. 2200 w. Elec Eng—June 16, 1897. No. 13464.

LAMPS.

220-Volt Lamps. Alfred H. Gibbings. Considers this lamp and the reasons for and benefits accruing from its adoption. 2000 w. Am Elect'n—June, 1897. No. 13392 C.

LIGHTING.

Artistic Electric Lighting. A criticism of the inartistic work often seen, and a description of a place recently opened in Glasgow, known as "Miss Cranston's New Lunch and Tea Rooms," which is highly praised. Ill. 2000 w. Elec Eng, Lond—June 18, 1897. No. 13722 A.

Municipal Ownership. M. J. Francisco. Criticisms unfavorable to municipal ownership, and claiming that reports made are not reliable. 3300 w. Elec Wld—June 5, 1897, No. 13325.

See same title under Railway Affairs, Maintenance of Equipment.

Why Some Lighting Plants Do Not Pay. F. C. Armstrong. Discusses principally failure by reason of mistakes in management and business methods. 2800 w. Can Elec News—June, 1897. No. 13477.

Municipal Lighting. W. Worth Bean. Abstract of a paper read before the National Electric Light Assn. at Niagara Falls. Opposed to municipal lighting. 2200 w. Elec Eng—June 16, 1897. No. 13459.

ROUEN, France.

Central Station of Rouen, France. Jules Laffargue. An illustrated detailed description of one of the most interesting stations in France, both in consequence of special features, and good results. 3000 w. Am Elect'n—June, 1897. No. 13385 C.

SMALL Towns.

Electrical Plants for Small Towns. Alexander Dow. Read before the Engineering Soc. of Univ. of Mich. Calls attention to points to be

considered in relation of design, location, &c., and to details often overlooked. 8000 w. Technic—1897. No. 13759 D.

SPRINGFIELD, Mass.

The Indian Orchard Water Power Transmission Plant of the United Electric Light Co., Springfield, Mass. An illustrated account of the water power station which has brought about the shutting down of the company's steam plant and practically transferred its generating plant beyond the city limits. 2500 w. Elec Eng—June 9, 1897. No. 13336.

STATION.

A Modern American Central Station. F. W. Roller. Illustrated description of the plant of the Suburban Electric Co., Elizabeth, N. J. 3000 w. Am Elect'n—June, 1897. No. 13383 C.

The Polyphase Station at the Budapester Allgemeine Electricitäts Gesellschaft. Francis Jehl. Illustrated description with information regarding efficiency. 2500 w. Elect'n—June 18, 1897. No. 13721 A.

STEAM Power.

The Steam End of an Electric Plant. A. M. Wickens. An inquiry into the working, the efficiency and cost of operating an electrical plant by steam. 2500 w. Can Elec News—June, 1897. No. 13482.

SWITCHBOARDS.

Central Station Switchboard Construction. Albert B. Herrick. Discusses designs and devices used in switchboard operation, and the working of the various systems. Ill. 3000 w. Elec Wld—June 26, 1897. No. 13749.

TACHOMETER.

A Simple Electrical Recording Tachometer. L. E. Jones. Describes and illustrates a tachometer constructed and used by the writer at the electric light plant of the West Chicago parks, that proved itself useful in quickly and accurately indicating the number of revolutions, as well as any slipping occurring in the many clutches, the jack drive, the rope drive and pulleys. 1200 w. Elec Rev—June 23, 1897. No. 13646.

WATER Power.

Water Driven Plants. John Murphy. Read before the Can. Elec. Assn. Deals in a general manner with the operation of water driven lighting and power plants. 1100 w. Can Elec News—June, 1897. No. 13481.

WIRING.

Report of the National Electric Light Assn. Committee on Safe Wiring. Presented at the Niagara Falls meeting. Reports the obstacles overcome and work done by the committee. 2400 w. Elec Eng—June 16, 1897. No. 13462.

Some Things About Wiring and Wiremen. S. H. Sharpsteen. Part first calls attention to the fact that every job has some new condition to meet, and briefly discusses where to enter with the service wires. 1500 w. Elec Eng—June 30, 1897, Serial. 1st part. No. 13814.

POWER.

ACCUMULATORS.

Note on the Theory of Lead Surfaces. (Ein Beitrag zur Theorie des Bleisammlers) Discussing the chemical and electrical action of leaden plates in accumulators. 5000 w. Zeitschr f Elektrochemie—June 5, 1897. No. 13594 B.

The Blot Accumulator. (Der Blot Akkumulator.) This new storage battery cell is composed of narrow strips of corrugated lead, wound on leaden bobbins, these latter being built up into plates. Tests by d'Arsonval, de Nerville, and Preece, show most excellent results. 1500 w. Zeitschr d Ver deutscher Ing—May 22, 1897. No. 13500 B.

The Dependence of Capacity of Accumulators upon the Strength of Charging Current. (Ueber die Abhängigkeit der Kapacität von der Entladestromstärke bei Bleiakkumulatoren) Giving the results of numerous tests of the various makes of accumulators, by Prof. Penkert. 1500 w. Elektrotechnische Zeitschr—May 20, 1897. No. 13572 B.

The Use of Accumulators in Central Station Practice. Clayton H. Sharp. Read before the Electrical Soc. of Cornell Univ. Discusses the advantages accruing from the use of an auxiliary accumulator plant in caring for irregular loads. 3000 w. Sib Jour of Engng—June, 1897. No. 13428 C.

ALTERNATING Current.

The Use of Alternating Current. Part first considers its application to street railway service, phase relation, impedance, capacity, self-induction, wave forms and torque. Ill. 3000 w. St. Ry Rev—June 15, 1897. Serial. 1st part. No. 13491 C.

CIRCUITS.

Economy in Circuits. D. H. Keeley. Diagrams and explanation with the view of showing that without exceeding the weight of copper, or the drop of E. M. F. in current transmission, found in a single parallel system, it is possible to provide for distribution with an equalized pressure at all points. 1200 w. Can Elec News—June, 1897. No. 13479.

COMMUTATORS.

See same title under Mechanical Engineering, Shop and Foundry.

CONTINUOUS Current.

Interaction between Armature and Field in the Continuous Current Dynamo. H. H. Norris. Describes the commutator and its use, with its action. 1500 w. Sib Jour of Engng—June, 1897. No. 13426 A.

CONVERTER.

The Rotary Converter. C. P. Steinmetz. Discussion of the subject, applying principally to polyphase rotary converters. 3000 w. Sib Jour of Engng—June, 1897. No. 13423 C.

DROP.

Drop in Alternating-Current Lines. Ralph D. Mershon. Treats this subject in such a manner that the results may be turned to practical advantage. 3500 w. Am Elect'n—June, 1897. No. 13391 C.

DYNAMO Calculation.

The Induction Factor, a New Basis of Dynamo Calculation and Classification. Charles A. Carus-Wilson. Read before the N. E. L. A. Showing the use of the induction factor in dynamo calculations, giving examples. 2500 w. Elec Eng—June 16, 1897. No. 13460.

DYNAMOS.

Interpretation of Dynamo Characteristics. H.

J. Hotchkiss. Read before the Electrical Soc. of Cornell Univ. The aim of the paper is to call attention to a few of the fundamental ideas that may serve as a general basis for the interpretation of characteristic curves. 1200 w. Sib Jour of Engng—June, 1897. No. 13429 C.

See Mechanical Engineering, Engines and Motors.

ELECTRIC Power.

See same title in Marine Engineering.

ELECTRICAL Transmission.

See same title under Mining and Metallurgy, Coal and Coke.

EXTENSIONS.

Profitable Extensions of Electricity Supply Stations. Abstract of paper read before the convention of the National Electric Light Assn., by Arthur Wright. An endeavor to show the most profitable fields for extension and profit-earning. 1800 w. Elec Wld—June 12, 1897. No. 13445.

LEAKAGE.

The Best Means of Effectually Preventing the Leakage of Current to "Earth" in Electrical Installations from Generating Heat and Setting Buildings on Fire. Sydney F. Walker. Considers (1) what do we mean by earth? (2) how does leakage of current to earth occur in electrical installations? (3) how does this leakage current generate heat? (4) what are the best means for its prevention? 3700 w. Elec Eng, Lond—June 11, 1897. Serial. 1st part. No. 13632 A.

LINE Effects.

The Line Effects in Alternating-Current Transmission. H. E. Raymond. A recital of some "line" incidents resulting from some of the most prominent of the so-called "effects." 1800 w. Am Elect'n—June, 1897. No. 13-390 C.

MACHINERY.

See same title under Mining and Metallurgy, Coal and Coke.

OGDEN, Utah.

The Power Plant of the Pioneer Electric Power Company of Ogden, Utah. Detailed description of an interesting piece of engineering work, as given in a paper by Henry Goldmark, presented to the Quebec convention of the American Soc. of Civ. Engs. Ill. 7500 w. Eng Rec—June 19, 1897. Serial. 1st part. No. 13497.

POTENTIOMETER.

The Direct Reading Potentiometer. Description of instrument made by Messrs. Elliott Bros., with illustrations. The method of making tests and measurements with it is also described. 3000 w. Elec Rev, Lond—June 11, 1897. No. 13633 A.

POWER

Multiple-Expansion Engines and the Cost Account. R. H. Thurston. The purpose of the article is to state briefly the facts and principles mainly influential in determining the best engine to adopt for a light or power station. 5000 w. Am Elect'n—June. No. 13388 C.

POWER Distribution.

Electric Power Distribution at Sandycroft. Illustrates and describes some parts of the system in use by the Sandycroft Foundry and Engine Works Co. 1000 w. Elec Rev, Lond—June 18, 1897. No. 13739 A.

POWER Plant.

The Electric Power Plant of the New Reichstags Building in Berlin. (Elektromoterische Antriebe im neuen Reichstagshause zu Berlin.) Describing the elaborate electric driving system for ventilators, and pumps, with illustrations. 2500 w. Zeitschr d ver deutscher Ing—May 29, 1897. No. 13504 B.

POWER Transmission.

The Economies of Power Transmission. Louis Bell. Discusses the items of cost and the probable sources of revenue. 3000 w. Am Elect'n—June, 1897. No. 13387 C.

STATION.

Electric Station Design. I. J. Macomber. Read before the Electrical Soc. of Cornell Univ. Considers only the design of stations that use steam as a motive power. Ill. 3000 w. Sib Jour of Engng—June, 1897. No. 13427 C.

STEAM TURBINE.

The Application of the Steam-Turbine to the Working of Dynamos and Alternators. Charles Algernon Parsons. Brief description of the compound steam-turbine and statement of its advantages for driving dynamos and alternators, with short discussion. Presented at Civil Engineers Conference. 1200 w. Elec Eng, Lond—May 28, 1897. No. 13292 A.

TIDE Power.

The Application of Electricity to the Utilization of Natural Water Power. (Die Auwendung der Elektrischen Kraflübertragung auf die Nutzbarmachung der Natürlichen Wasserkräfte.) A discussion by Dr. Voller, of the possibility of utilizing tide power with especial reference to the proposed application at Hamburg. 3000 w. Die Elektrizitat—May 8, 1897. No. 13566 B.

TRANSFORMATION.

Frequency Transformation. F. Jarvis Patten. Considers this subject and describes an apparatus from which almost any desired frequency can be derived from a given frequency. Ill. 2700 w. Elec Wld—June 12, 1897. No. 13446.

TRANSMISSION.

See Mechanical Engineering, Power and Transmission.

The Long Distance Electrical Transmission Between Folsom and Sacramento, Cal. Illustrated detailed description. 4500 w. Eng, Lond—June 11, 1897. No. 13618 A.

The Niagara Power Transmission Line. J. G. White. History and description. 3500 w. Elec Eng—June 16, 1897. No. 13463.

The Transmission of Power. A discussion of the subject of the modes of transmitting power concluding with three facts that point strongly to the ultimate triumph of electrical transmission for a large portion of industrial conditions. 3000 w. Eng, Lond—June 4, 1897. No. 13410 A.

TELEGRAPHY AND TELEPHONY.

AUTOMATIC Telegraphy.

Automatic Telegraphy. Patrick B. Delany. Part first discusses the best speed obtainable with the Morse and with the Wheatstone system. 2200 w. Elec Eng—June 23,1897. No. 13-716.

BERLINER Patent.

The Berliner Patent and the Government Suit. R. S. Taylor. Address of the chief counsel for the government in the Berliner case, at the Convention of Independent Telephone Assn. 4000 w. Elec Wld—June 26, 1897. No. 13752.

CABLES.

The Burke System of Cable Telegraphy. Mr. Charles G. Burke's invention is an adaptation of Morse work to long submarine cables and other telegraph lines where large static capacity is an obstacle to the use of ordinary Morse signals. Ill. 1200 w. Elec Eng—June 23, 1897. No. 13717.

The Electrostatic Capacity of a Two-Wire Cable. George W. Patterson. Briefly derives the expression for the capacity of a single wire cable and from that passes to the capacity of a two-wire cable. 700 w. Technic—1897. No. 13766 D.

The Working of the Telegraph Cable from Germany to Norway. Albert Petersen. Abstract of an article in the *Elektrotechnische Zeitschrift*, translated from the *Telegrafbladet*. A statement of difficulties and method devised to remedy them. 800 w. Elect'n—June 11, 1897. No. 13626 A.

CONNECTIONS.

Trunk Line Connections for Independent Telephone Exchanges. Some remarks concerning the proper methods for the establishment and maintenance of trunk lines between various exchanges. 1700 w. Elec Wld—June 19, 1897. No. 13628.

DUPLEX Telegraphy.

A New Duplex Telegraph System. (Neues Zweifach telegraphensystem.) A simple system which has worked well without condensers over a line 230 miles long, for over three years. 2000 w. Elektrotechnische Zeitschr—May 13, 1897. No. 13571 B.

Duplex Telegraphy in Switzerland with the Hughes Apparatus. (Duplex telegraphie mit dem Hughes-Apparat in der Schweiz.) Describing the performance of the first Hughes duplex line in Switzerland, between Bern and Basle. 2000 w. Elektrotechnische Zeitschr—May 20, 1897. No. 13573 B.

INDEPENDENT Telephones.

Independent Telephone Companies.—Their Legal Status and Their Prospects for the Future. A. B. Guigon. Discusses the effect of the recent decision in the Berliner patent, and the union now forming, with matters to be considered at the coming meeting in Detroit. 2000 w. Elec Wld—June 19, 1897. No. 13629.

Meeting of Independent Anti-Bell Telephone Interests at Detroit, June 22 and 23, 1897. Account of meeting, presidential address, &c. 16500 w. Elec Eng—June 23, 1897. No. 13718.

The Independent Telephone Movement. James M. Thomas. Presidential address discussing the attitude of this organization to the Bell Telephone Co. 2400 w. Elec Wld—June 26, 1897. No. 13751.

MILITARY Telegraph Lines.

Pole Climber and Pole Sinking Tool on the U. S. Military Telegraph Lines. W. A. Glassford. Description of tool and its working. 1200 w. Elec Eng—June 23, 1897. No. 13715.

RESONANCE.

Electrical Resonance. Remarks on this subject, with reference to a paper read before the Chicago Electrical Assn., by Kempster B. Miller. Ill. 1800 w. Elec Rev, Lond—June 4, 1897. No. 13397 A.

TELEPHONES.

Telephone Lines. Considers the troubles arising from earth's magnetic disturbances, leakage currents, and inductive effects of neighboring conductors. 1300 w. Am Elect'n—June, 1897. No. 13393 C.

The Stromberg-Carlson Telephone Apparatus. Illustrated detailed description. 1500 w. Elec Rev—June 30, 1897. No. 13753.

TELEGRAPHY Without Wires.

Ethereal Telegraphy. Editorial on the investigations in this field. 1800 w. Eng, Lond—May 28, 1897. No. 13319 A.

Signalling Through Space Without Wires. W. H. Preece. Delivered before the Royal Institution, June 4, 1897. Explains the system of telegraphy invented by Signor Guglielmo Marconi, and describes his own experiments. Also editorial. Ill. 4800 w. Elec Rev, Lond—June 11, 1897. No. 13634 A.

MISCELLANY.

COST.

The Cost of Electric Energy in 1896. A. P. Haslam. Graphical representation, with explanation, showing that progress has been the rule, and the prosperous condition of the electricity supply business. 1700 w. Elec, Lond—June 18, 1897. Serial. 1st part. No. 13725 A.

CURRENT Price.

The Establishment of a Base Price for Current. J. B. Cahoon. Abstract of paper read before the N. E. L. A. Outlines a plan for determining the base price which should be charged per kilowatt hour. 1400 w. Elec Eng—June 16, 1897. No. 13461.

ELECTRICAL Machinery.

Repairs of Electrical Machinery. False Alarms. A. R. Harris. Shows that when a machine behaves abnormally, there is often simply some part slightly out of adjustment, or an accumulation of dirt at some point where it can interfere with the proper action. Ill. 2000 w. Am Mach—June 10, 1897. No. 13371.

ELECTRICAL Waves.

Electrical Waves and Oscillation. Ernest Merritt. Read before the Electrical Soc. of Cornell Univ. Explains experiments illustrating electrical oscillations and waves, and gives such information as has thus far been gained in regard to them. 5200 w. Sib Jour of Engng—June, 1897. No. 13430 C.

FURNACE.

A New Electric Furnace, (Nouveau Four Électrique.) The Lelièvre furnace is of the cupola type with carbons at bottom, and the escaping gases are used to heat the incoming material. 1000 w. La Revue Technqiue—May 10, 1897. No. 13541 D.

FUTURE Possibilities.

The Future Possibilities of Electricity. F. A. C. Perrine. An attempt to show how it will be

possible for this new means of power transmission and utilization to change certain industries, and to prove that these changes will materially influence localities. 3800 w. Elec Engng—July 1, 1897. No. 13772.

GALVANOMETER.

On the Measurement of Alternate Currents by Means of an Obliquely Situated Galvanometer Needle, with a Method of determining the Angle of Lag. Lord Rayleigh. From the Phil. Mag. Describes a form of galvanometer suitable for the measurement of alternate currents, and how the instrument can be used to measure the power factor of a circuit. 2200 w. Elect'n—June 4, 1897. No. 13420 A.

MAGNETISM.

See Mining and Metallurgy, Iron and Steel.

NIAGARA FALLS.

Electricity at Niagara Falls. A brief and concise review of the present situation with respect to electrical development, with particular reference to the newest applications and to details of operation. Ill. 5700 w. Am Elect'n—June, 1897. No. 13389 C.

Niagara Falls as an Electrical Center. Orrin E. Dunlap. Describes the changes wrought and calls attention to the installations of special interest to electricians. Ill. 2400 w. W Elec—June 12, 1897. No. 13415.

The Electrical Features of Niagara. Illustrated description of the Niagara Falls Power Co., the Power Transmission Line, the Railway, Hydraulic Power & Manufacturing Co, the Carborundum Co., and other industries. 7000 w. Elec Wld—June 5, 1897. No. 13328.

PHYSIOLOGICAL Electricity.

Physico-Chemical Principles and the Application of Cataphoris in Medicine. (Physikalisch Chemische Grundlage und Anwendung der Kataphorese in der Medizin.) A fundamental discussion of the application of the electrical transfer of particles to medicine. 6000 w. Elektrochemische Zeitschr—June, 1897. No. 13588 B.

ROENTGEN Rays.

A Speculation Regarding the Cause of Roentgen Rays. Elihu Thomson. Speculations presented in the hope that they may aid in investigation. 2000 w. Elec Wld—June 26, 1897. No. 13748.

SAFES.

Burglarizing Safes by Electricity. L. L. Summers. An account of experiments made, with charts giving some of the results, showing that any arguments based upon the assumption that a metal wall cannot be penetrated by currents obtained from electric light plant, or storage battery, are fallacious. 1000 w. Elec Engng—June 15, 1897. No. 13303.

SAFETY Fuse.

A New System of Electric Protection. (Einneues System Elektrischer Sicherungen.) The improved Hundhausen safety cut-out which throws in a suitable resistance when melted is now used by Siemens & Halske in the latest installations. Two articles. 5000 w. Die Elektrizität—May 22, June 5, 1897. No. 13568 D.

VOLTAMETER.

The Copper Voltameter. (Ueber das Kupfer-Voltameter.) Describing the practical use of the voltameter for electrical measurements by the decomposition of copper solutions. Two articles. 6000 w. Zeitschr f Elektrochemie—May 5, 20, 1897. No. 13591 E.

MARINE ENGINEERING.

AMERICAN Shipping.

What American Shipping Means to American Labor. From the *American Economist*. Showing how the United States can benefit by a proper maritime policy. 1800 w. Sea—June 24, 1897. No. 13675.

BATTLESHIPS.

Naval Review at Spithead. Illustrated account, with description of the various battleships belonging to Great Britain. Also editorial. 2000 w. Eng, Lond—June 18, 1897. No. 13732 A.

BULKHEADS.

Marine Registry Rules for Watertight Bulkheads in Mail and Passenger Steamers. (Vorschriften der Seeberufsgenossenschaft über Wasserdichte Schotte für Post- und Passagierdampfer.). A paper by Herr Middendorf, discussing the method of determining the number and location of watertight bulkheads, with many illustrations and working diagrams. The official method of the German Lloyds. Two articles. 1 plate. 12000 w. Zeitschr d Ver Deutscher Ing—May 29, June 5, 1897. No. 13503 E.

CARRYING-TRADE.

The Upbuilding of a Marine Carrying-Trade. John Codman. An argument for free ships, in answer to Lewis Nixon. 3200 w. Eng Mag—July, 1897. No. 13803 B.

CRUISERS.

American Built Cruisers for Japan. Illustrated description of a vessel to be built by the Union Iron Works of San Francisco. 900 w. Sci Am—July 3, 1897. No. 13768.

ELECTRIC Power.

Electricity on Shipboard. W. F. Durand. Read before the Electrical Soc. of Cornell Univ. Describes in detail the various applications. 4000 w. Sib Jour of Engng—June, 1897. No. 13425 C.

LAKE Shipping.

Wonders of Lake Shipping. Remarks on the enormous traffic of the Sault canal, the big vessels and despatch in loading. 1200 w. Bos Jour of Com—June 19, 1897. No. 13623.

NEW NAVY.

Three Samples from the New Navy. Illustrated description of the armored cruiser, New York, the battleship, Iowa, and the double-turreted monitor, Puritan. 1500 w. Am Mach—June 17, 1897. No. 13467.

OCEAN Travel.

The Place of Our Destination. John E.

Sweet. A comparison between a journey just completed, and one made thirty-five years ago is given in part first. 1600 w. Am Mach—June 17, 1897. No. 13470.

PADDLE Steamships.

Largest Paddle Steamship Afloat, British or American? Descriptions, with illustrations of the British steamship Empress Queen, being constructed for service in the Irish Sea, and the Priscilla of the Fall River Line, running from New York. 1200 w. Marine Engng—June, 1897. No. 13357 C.

PROPELLERS.

The Construction of Propellers. (Konstruktion von Schiffschrauben.) Giving a graphical solution by the projection of points from a hyperbola. 1200 w. Zeitschr d Ver Deutscher Ing—May 22, 1897. No. 13501 B.

QUARANTINE.

Quarantine and Port Sanitation. A. N. Bell. A forty years' review of the port of New York. Ill. 9800 w. San—June, 1897. No. 13-449 D.

REVENUE Cutter.

U. S. Revenue Cutter McCulloch for Service in Behring Sea. Illustrated description with trial trips and data. 1700 w. Marine Engng—June, 1897. No. 13356 D.

STEAMSHIPS.

The New Twin Screw Express Steamships of the North German Lloyd Company. Illustrated description of the Kaiser Wilhelm der Grosse and the Kaiser Friedrich. 1200 w. Sci Am—June 19, 1897. No. 13466.

The "William the Great" ("Kaiser Wilhelm der Grosse.") A description of the launch of this large vessel, with illustrations. The ship is 2,500 tons displacement, 648 feet long, 66 feet beam, 43 feet deep. 1500 w. Stahl und Eisen—June 1, 1897. No. 13562 D.

TIME.

International Unification of Time. (L'Unification Internationale des Heures.) A discussion of the subject of standard time for Europe, based upon the same system as that used in the United States. But three meridians would be necessary for all Europe. 3500 w. Le Génie Moderne—June 1, 1897. No. 13537 B.

TORPEDO Vessels.

The Battleship and the Torpedo Vessel. Editorial on the discussion at the Royal United Service Institution on the relative military virtues of the battleship and torpedo vessel, especially discussing Admiral Colomb's paper entitled "The Future of the Torpedo." 2200 w. Engng—June 11, 1897. No. 13610 A.

U. S. NAVY.

The American Fleet. J. D. Jerrold Kelley. Illustrative descriptive review of the ships of the United States navy. 7000 w. Harpers Wk—June 19, 1897. No. 13439.

VIBRATIONS.

Steamship Vibrations, with Records of Recent Observations. W. F. Durand. Part first discusses unbalanced reciprocating parts, unbalanced cranks, and unbalanced pressure on the guides. 3000 w. Marine Engng—June, 1897. No. 13358 C.

WATER TUBE Boiler.

Test of the Engel Marine Water Tube Boiler. Herbert G. Geer. Illustrates the general arrangement and gives account of test. 900 w. Power—July, 1897. No. 13783.

YACHTS.

A Modern Steam Yacht. Interesting description of the beautiful yacht built for Mr. Ogden Goelet, by the Clydebank Engineering and Shipbuilding Co. 3500 w. Engng—June 18, 1897. No. 13711 A.

Ancient Roman Yachts. From the N. Y. Sun. An account of the finding of the two ships of the Emperor Caligula, which have been buried for centuries at the bottom of Lake Nemi. 1000 w. Eng—June 5, 1897. No. 13368.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER Feeder.

A New Way to Feed Boilers. Illustrates an apparatus for supplying boilers with feed water with a much smaller expenditure of steam than is necessary with pumps. The Q. & C. Scott Boiler Feeder. 1200 w. Am Mach—June 17, 1897. No. 13468.

BOILER-SETTING.

Boiler-Setting and Furnace-Construction. Edgar Kidwell. Showing the requirements of boiler-setting and how to obtain them. Ill. 5200 w. Eng Mag—July, 1897. No. 13811 B.

HIGH-SPEED Engines.

Some Facts and Fancies Concerning High-Speed Engines. W. F. Cleveland. A letter to the editor objecting to the use of heavy reciprocating parts. 1000 w. Loc Engng—June 1897. No. 13330 C.

HYDRAULIC Pressure.

Experiments in Bursting a Boiler by Hydraulic Pressure. The boiler tested was built by the John O'Brien Boiler Works Co. of St. Louis, the object being to determine the strength of two different styles of rivetted joints. Ill. 350 w. Eng News—July 1, 1897. No. 13820.

INSPECTION.

Boilers as the Inspector Finds Them. George B. Hartley. Discusses the causes of explosions, the demand for high-pressure boilers, with consideration of various types of boilers, &c. Discussion follows. Ill. 5800 w. Pro Engs' Club of Phila—April, 1897. No. 13334 D.

SMOKE.

The Smoke Nuisance and Its Regulation with Special Reference to the Condition Prevailing in Philadelphia. Discussion at meeting of the Franklin Institute. 8500 w. Jour Fr Inst—June, 1897. No. 13284 D.

WATER TUBE Boiler.

See same title under Marine Engineering.

COMPRESSED AIR.

AIR Compressor.

High-Pressure Air Compressor and Receiver

for the Hardie Locomotive. Views and description of the air-compressor and the receiver or storage reservoir which provide and maintain the supply of compressed air. 800 w. Am Mach—June 10, 1897. No. 13370.

Hydraulic Air-Compressing Plant. C. H. Taylor. Extract from a paper read at meeting of Mining Engineers in Montreal. The compression was effected by the flow of water down a vertical pipe, the air being collected in a receiver. Ill. 2400 w. Eng, Lond—June 11, 1897. No. 13617 A.

Notes on Air Compressors. Robert Peele. An article intended particularly for the use of students in mining engineering. Part first treats of the general structure of compressors, the compression of air, wet compressors, dry compressors, piston clearance in air cylinders, and compound or stage compression. Ill. 8500 w. Sch of Mines Quar—April, 1897. Serial. 1st part. No. 13453 D.

The Philadelphia Compound Air Compressor. Illustrated description of the principal features of the new compound air compressor built by the Philadelphia Engineering Works. 1800 w. Ir Age—June 17, 1897. No. 13456.

COMPRESSED AIR Locomotive.

See same title under Street and Electric Railways.

HIGH ALTITUDES.

The Use of Compressed Air at High Altitudes. W. W. F. Pullen. A few notes on the results of the application of the air compressor at high altitudes. 1200 w. Prac Eng—May 28, 1897. No. 13360 A.

LIQUEFIED Air.

Compressed and Liquefied Air. Leland L. Summers. A consideration of the application of elementary principles of physics to this subject, and the prospect of increasing the economy of compression. 1800 w. Elec Engng—July 1, 1897. No. 13773.

MINING.

The Use of Compressed Air for Mining Purposes. Edward A Rix. A lecture delivered to the engineering students of the Leland Stanford, Junior, University. Considers the proper conditions under which to compress and use air, and the requirements of a modern air compressor, and the compressed air motor. Thinks this the only system which is alone sufficient to supply all the power needs of an average mine. 8500 w. Elec Engng—June 15, 1897. No. 13302.

ENGINES AND MOTORS.

DYNAMOS.

Modern Ideas in Dynamo Construction. (Neuere Anschauungen in Dynamobau.) Discussing the influences of material, winding and general proportions in the light of recent experience. 5000 w. Zeitschr d Ver deutscher Ing—May 22, 1897. No. 13502 B.

On Dynamos. W. M. Mordey. Read before the Institution of Elec. Engs. The development of the dynamo and a discussion of its value and means of improving dynamos. Ill. 5300 w. Elect'n—May 28, 1897. Serial. 1st part. No. 13346 A.

The Problem of the Small Air-Space Dynamo. H. B. Atkinson. Discussing a paper by W. M. Mordey on Dynamos. 1800 w. Elect'n—June 11, 1897. No. 13625 A.

ELEVATOR Engines.

A Comparison Between Vertical and Horizontal Cylinder Hydraulic Elevator Engines W. S. Huyette. Part first notes the things to be considered in selecting the type of engine best adapted for a specified purpose, with account of test and description of a vertical cylinder engine. Diagram. 2200 w. Power—July, 1897. Serial. 1st part. No. 13782.

GAS Engines.

Gas Engines. W. F. Kelly. Read before the Engineers Club, Columbus, O. Brief reference to the earlier types showing the developments to the present successful type, with consideration of the theory upon which the gas engine operates. 4400 w. St Ry Rev—June 15, 1897. No. 13489 C.

MOTORS.

Shunt Motors for Car Propelling. (Zur Frage der Nebenschlussmotoren für Bahnbetrieb.) Claiming a higher efficiency and steadier motion, together with better commercial results for the shunt motor. 1500 w. Elektrotechnische Zeitschr—May 27, 1897. No. 13574 B.

Single-Phase Motors. Ernst J. Berg. Discusses the different types and their disadvantages. 1500 w. Am Elect'n—June, 1897. No. 13386 C.

PELTON Motor.

An Efficiency Surface for Pelton Motor. W. Kendrick Hatt. Paper presented to Indiana Academy of Sciences. A mathematical study. 700 w. Jour Fr Inst—June, 1897. No. 13287 D.

PUMPING Engine.

A Curious Pumping Engine at the Ridgewood Pumping Station of the Brooklyn, N. Y., Water Works. Illustrated detailed description. 1500 w. Power—July, 1897. No. 13781.

QUADRUPLE Expansion.

The Economy of Quadruple Expansion Engines. Arthur O. Druhsler. Describes the anti-vibration system and investigates the economy of this class and their ability for practical working. Diagrams. 1300 w. Ind Engng—May 1, 1897. No. 13282 D.

STEAM TURBINE.

See Electrical Engineering, Power.

The de Laval Steam Turbine. (Die de Laval-'sche Dampfturbine.) Illustrated description of the de Laval steam turbine, especially as applied to dynamo driving. 3500 w. Die Elektrizität—June 5, 1897. No. 13569 B.

POWER AND TRANSMISSION.

BELTING.

Rules Governing the Width of Leather Belting. J. J. Flather. Considers the problems of belting, the things to be considered in determining the size of belt, tests of strength, durability, cost, and related matters. 3500 w. W Elec—June 12, 1897. No. 13417.

CABLEWAY.

Cableway for Transportation of Millstone. (Chemin de Fer Aérien pour le Transport de Pierres Meulières.) An account of the overhead cableway at Barzy. The distance is 3450 feet, with a difference in level of 456 feet; 300

tons of stone are transported in 10 hours. 2500 w. La Revue Technique—May 25, 1897. No. 13543 D.

GENERATING Plant.

Should Generating Plant be Mounted on Springs? James Swinburne. Remarks and brief discussion at Civil Engineers' Conference. 1600 w. Elec Eng, Lond—May 28, 1897. No. 13291 A.

MILLS.

Loss of Power in Mills. M. W. Danielsen. Calls attention to conditions that affect belts and so cause loss of power, and suggests remedies. Ill. 1400 w. Age of St—June 5, 1897. No. 13299.

PULLEYS.

Step or Cone Pulleys. Samuel Webber. Explains how to determine the diameter of a set of step or cone pulleys when a number of different speeds are constantly required. 1000 w. Clay Rec—June 14, 1897. No. 13643.

TRANSMISSION.

See Electrical Engineering, Power.

The Transmission of Power. William Henry Preece considers its transmission by electricity, Edward Bayzand Ellington, by water, and John Hopkinson all other methods, in papers read before the Civil Engineers' Conference, and these are discussed by the members. 5500 w. Elec Eng, Lond—May 28, 1897. No. 13290 A.

WATER Power.

The Control of Unused Water Rights. (Ueber die Frage des Heimfalles von Verliehenen Wasserrechten.) An official investigation into the value and ownership of numerous water rights in Austria, with an interesting technical discussion as to the value and availability of water power in general. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—May 21, 1897. No. 13515 B.

The Limitations of Government in Water-Power Plants. Mark A. Replogle. Names and briefly discusses the factors which determine the speed of a water-wheel. 1000 w. Min & Sci Pr—June 5, 1897. No. 13372.

WATER WHEELS.

A Study in the Replacement of Water-Wheels. (Studie über Auswechslungen von Wasserrädem bei Bestetienden Wasserwerken.) A discussion of the data to be taken into consideration when replacing the wheels in an existing plant by those of another construction; with a practical example. 1500 w. Oesterr Monatschr f d Oeffent Baudienst—June, 1897. No. 13531 D.

Hurdy-Gurdy or Tangential Water-Wheels. Philip R. Bjorling. Illustrated description of these wheels and the manner in which they are regulated. 2000 w. Col Guard—June 4, 1897. No. 13414 A.

Impulse Water-Wheel Experiments. E. A. Hitchcock. Explains the theoretical action of the wheel, and reports experiments carried on in the Ohio State University laboratory. 1000 w. Elec Wld—June 5, 1897. No. 13324.

WINDMILLS.

Results of Windmill Tests. E. C. Murphy. Tests made during the summer of 1896, on large steel mills working large pumps and raising water for irrigating purposes. 1400 w. Kan Univ Quar—April, 1897. No. 13473 D.

SHOP AND FOUNDRY.

ARMATURES.

The Construction of Armature Coils. William Baxter, Jr. Explains methods of construction and forms, with illustrations. 1700 w. Am Mach—July 1, 1897. No. 13779.

BEARINGS.

Machinery Bearings of Aluminum. F. A. Farnsworth. Experiments showing that aluminum bronze need not be a failure as a bearing metal. Ill. 700 w. Am Mach—June 24, 1897. No. 13657.

BRASS.

Aluminum, Manganese and Silicon in the Brass Foundry. F. J. Davis. Read at the convention of the American Foundrymen's Assn., at Detroit. Discusses the advantages of each metal. 1400 w. Ir Trd Rev—June 24, 1897. No. 13678.

Gating Small Patterns for Brass. C. Vickers. An endeavor to point out the best way to gate patterns from which brass castings are to be made, so as to produce the greatest percentage of good castings with the least expenditure of time on the part of the moulder. Ill. 1300 w. Am Mach—June 24, 1897. No. 13655.

CAST Iron.

Malleable Cast Iron. George Parker Royston. An account of the investigation carried out by the author on the manufacture of malleable cast-iron. 3400 w. Prac Eng—May 28, 1897. No. 13361 A.

COMMUTATORS.

Making and Repairing Commutators. L. C. Sharpe. Drawing and explanation of how to put up a repair-shop commutator. 1800 w. Am Mach—June 24, 1897. No. 13656.

DIES.

Bending Dies for Press Work. J. L. Lucas. Illustrated description of three dies for this class of work. 500 w. Am Mach—June 24, 1897. No. 13654.

ELECTRICAL Machinery.

Electrical Machine Shop Practice. James F. Hobart. The first of a series of articles giving a description of shop practice as exemplified in the construction of electrical machinery. 1000 w. Elec Eng—June 23, 1897. Serial. 1st part. No. 13713.

ELECTRICITY.

Electricity in the Modern Machine Shop. Louis Bell. Cost-reduction and labor-saving by electric applications. Ill. 3200 w. Eng Mag—July, 1897. Serial. 2d part. No. 13810 B.

FACINGS.

Foundry Facings. H. F. Frohman. Read at Chicago meeting of Western Foundrymen's Assn. Discusses different kinds of facings for different kinds of work. 2000 w. Age of St—June 19, 1897. No. 13622.

FLANGING

Hydraulic Flanging Machine. Illustrated description of machine and method of operation. 1000 w. Am Mach—June 10, 1897. No. 13369.

MACHINE TOOLS.

Grinding Machines and Milling Machines for Locomotive Frames. (Schleifmaschine und Lokomotivrahmen Fräsmaschine.) Giving illus-

trations of the tools made by Collet & Englehard, of Offenbach a/M, and notable chiefly by the closeness with which they have followed American models. 5000 w. Zeitschr d Ver Deutscher Ing—June 5, 1897. No. 13506 B.

MANUFACTURING.

Manufacturing Methods as applied to the Production of Machinery. F. A. Halsey. Points out some of the means of maintaining dimensions and expediting work. The methods described relate specially to manufacture by aid of special fixtures, and refer to pure machine shop operations only. 3300 w. Sib Jour of Engng—June, 1897. No. 13421 C.

MILLING.

A Small Bench Milling Machine. A. H. Cleaves. Illustrated description of a bench milling machine that has been used to good advantage for many years in different shops. 1200 w. Am Mach—July 1, 1897. No. 13777.

Cast-Iron Milling Cutters. E. A. Gay. Description of milling cutters used by the Enterprise Foundry Co. of Rochester, N. Y., in the manufacture of butts and hinges, with illustrations of samples made with these tools. 1500 w. Am Mach—July 1, 1897. No. 13778.

MOLDING.

Molding Chemical Pans. George O. Vair. Drawings with description of a casting made by a process termed "skin-drying." 700 w. Am Mach—July 1, 1897. No. 13780.

PLANER.

How the Planer Was Driven. John Randol. Describes the drive of a planer in the Builders' Iron Foundry Machine Shop, Providence, R. I. 1200 w. Am Mach—June 17, 1897. No. 13469.

STEEL Pulley.

An All-Wrought Steel Pulley. Edward G. Budd. Describes an ordinary belt-wheel made entirely of steel and representing the highest development of the sheet metal workers art. Ill. 1500 w. Jour Fr Inst—June, 1897. No. 13286 D.

MISCELLANY.

BICYCLES.

Some Comments on the Essentials of Bicycle Design. E. H. Erhman. Discusses points in design and new features, giving special attention to bearings, driving gear and frame. Ill. 6000 w. Technic—1897. No. 13765 D.

COLLEGE.

A German Technical College from an English Point of View. Edwin O. Sachs. Deals principally with the architectural section and the courses available for students, with some historical and descriptive notes. 3000 w. Brit Arch—June 18, 1897. No. 13738 A.

DREDGING.

Pioneers of Centrifugal Pump Dredging. Letter to the editor from Frank E. Lesourd, criticizing the claims to inventions made by A. W. Von Schmidt and A. B. Bowers, with replies from the parties criticized. 5500 w. Eng News—June 17, 1897. No. 13488.

GEAR Teeth.

The Strength of Gear Teeth. John H. Barr. A study of the subject by the writer with results. 1000 w. Sib Jour of Engng—June, 1897. No. 13422C.

GRAPHOSTATICS.

The Internal Forces in a Framed Ring, Graphically Determined. (Die Innern Stabkräfte eines Belasteten Fackwerkringes, Graphisch Ermittelt.) An excellent graphostatic investigation of a framed ring using the cord- and force-polygon method. 3500 w. Schweizerische Bauzeitung—May 15, 1897. No. 13535 B.

HEAT Equivalent.

The Bakerian Lecture.—On the Mechanical Equivalent of Heat. Osborne Reynolds. Abstract of lecture before the Royal Society. Research to determine the mechanical equivalent of the total heat necessary to raise the temperature of water over the standard interval of temperature, and thus to obtain directly the equivalent of the mean specific heat between the freezing and boiling points. 1500 w. Nature—June 3, 1897 No. 13431 A.

MEASUREMENT.

The Decimal System in Engineering Measurement. Henry Riall Sankey. Read at Civil Engineers' Conference. Considers the advantage of the metric system and reports the results of its introduction into the works of Messrs. Willans and Robinson. Short discussion. 2000 w. Elec Eng, Lond—May 28, 1897. No. 13293 A.

MICROTOMES.

On Two Forms of Automatic Microtomes. Charles Sedgwick Minot. Describes the automatic wheel microtome, and the precision microtome; also a new form of microtome knife. Ill. 4500 w. Science—June 4, 1897. No. 13288.

MOTOR Cars.

Motor Cars at the Crystal Palace. An account of the entries and trial, in response to the prizes offered by this journal, with editorial comment. Ill. 6500 w. Eng, Lond—June 4, 1897. No. 13412 A.

The Present Status of Motor-Driven Vehicles for Common Roads. Editorial comment on the competitive trial planned by the London *Engineer*. 2300 w. Eng News—July 1, 1897. No. 13819.

NICKEL Plating.

Nickel Plating. Information relating to cleaning metals and nickel plating taken from a treatise published by the Zucker & Levett & Loeb Co. 4300 w. Ir Age—July 1, 1897. No. 13796.

PLANIMETER.

A New Moment Planimeter. (Ein Neues Momentenplanimeter.) A new form of planimeter by means of which the statical moment or the moment of inertia may be determined by mechanical integration. 3500 w. Schweizerische Bauzeitung—May 8, 1897. No. 13534 B.

SCHOOLS.

Preparatory Schools for Engineering Education. (Die Vorschulen für das Studium der Ingenieurwissenschaften.) A plea for better technical preparatory course than is at present given by the existing gymnasium, by Rector Schumann of the Realschule at Stuttgart. 5000 w. Zeitschr d Ver Deutscher Ing—June 5, 1897. No 13507 B.

The Relation of the Technical and Classical Schools in Karlsruhe. (Das Gutachten der Tech-

nischen Hochschule in Karlsruhe über die Oberrealschulen.) A contribution to the subject of education, which though local in its immediate allusions, shows very clearly the active discussion now going on throughout Germany for more practical education. 6000 w. Zeitschr d Ver deutscher Ing—June 12, 1897. No. 13508 B.

SKATING Rink.

Artificial Skating Rinks. (Künstliche Eislaufbahnen.) Illustrated description, with practical data, of artificial ice surfaces for skating, with especial reference to the rink at Nuremberg, 150x80 feet. 2500 w. Zeitschr d Ver deutscher Ing—June 12, 1897. No. 13509 B.

SPEED Indicators.

Speed Indicators and Recorders. (Tachometer und Tachographen.) Illustrating and describing Dr. Horn's improved apparatus. Two articles. 5000 w. Die Elektrizität—April 10, May 8, 1897. No. 13565 D.

TEXTILE Machinery.

The Textile Machinery in the exposition of 1896. (Die Maschinen der Textilindustrie auf den Ausstellungen des Jahres 1896.) Giving an illustrated account of the textile machinery shown at the Berlin exposition. Serial. 1st part. 5000 w. Zeitschr d Ver deutscher Ing—June 5, 1897. No. 13505 B.

WEDGE.

The Mechanical Advantage of the Wedge. W. W. F. Pullen. Showing the small mechanical advantage of the wedge. 900 w. Prac Eng—June 4, 1897. No. 13435. 30 cts.

MINING AND METALLURGY.

COAL AND COKE.

ALABAMA.

Coal and Iron in Alabama. William M. Brewer. A brief history of these industries is given as an introduction to a series of articles to be published in the same paper. 1400 w. Am Mfr & Ir Wld—June 25, 1897. Serial. 1st part. No. 13724.

BITUMINOUS Coal.

The Pennsylvania Coal Investigation. Editorial on the report of the committee appointed to investigate the condition of the coal trade in the bituminous districts of Pennsylvania. 1200 w. Eng & Min Jour—June 12, 1897. No. 13404.

COAL.

The Treatment of Coal. Continuation of the discussion of the papers read before the Inst. of Civ. Engs. by Mr. James Rigg, on "Tipping and Screening Coal," and Mr. Thomas Gillott, on "The Surface Plant at Kirkby Colliery." A summary of the discussion by correspondence. 9300 w. Col Guard—May 28, 1897. No. 13313 A.

COAL-WASHING.

Coal-Washing Installation at the Baltavara Mines (Asturias), Spain. Emilio Jimenez. Description with longitudinal and transverse sections. 1800 w. Col Guard—May 28, 1897. No. 13314 A.

Coal Washing. R. M. Hosea. A description of the Colorado Fuel and Iron Co.'s Washing at Sopris, Colo. The character of the coal, the advantages accruing from washing it, and the experiments which led up to the adoption of the present plant. 4000 w. Col Eng—June, 1897. Serial. 1st part. No. 13604 A.

ELECTRICAL Transmission.

On Electrical Transmission of Power in a Colliery. L. Gorchot. Translated from "Memoires de la Société des Ingenieurs Civils de France." A general account of a large electrical plant at a colliery in France, now in process of completion. 2800 w. Eng, Lond—June 11, 1897. No. 13619 A.

EXPLOSIONS.

Contributions to the Fire-damp Question. (Beiträge zur Schalagwetterfrage.) With especial reference to the relation of atmospheric conditions and the production of explosive gases in mines. 10000 w. Glückauf—May 8, 1897. No. 13578 B.

Remarkable Firedamp Explosion and Its Lesson. From a communication to *Glückauf*, by Berg ingenieur Lamprecht, Anina-Steierdorf, South Hungary. An account of the disaster and a study of the cause. 2200 w. Col Guard—June 18, 1897. No. 13727 A.

The Recovery of Coal Mines after Explosions. Mr. Garforth. Read before the Federated Institution of Mining Engineers. Submits a number of rules suggesting precautions to be taken by the manager before an accident, and rules for guidance after an explosion. 3200 w. Col Guard—June 11, 1897. No. 13612 A.

EXPLOSIVES.

The Use of Explosives in Coal mines. An order modifying the restrictions imposed by a previous order, with reference to the use of explosives in coal mines. 3000 w. Col Guard—June 18, 1897. No. 13726 A.

FUEL.

Methods of Fuel Analysis. A review of a work by G. Arth, with extracts showing its practical nature. 2000 w. Col Guard—June 4, 1897. No. 13413 A.

The Heating of Boilers with Pulverized Coal (Le Chauffage des Chaudières au Charbon Pulvérisé.) Describing and illustrating the Ruhl system applied to a double flue boiler. 1000 w. La Revue Technique—May 25, 1897. No. 13546 D.

HEATING Power.

Determination of the Heating Power and Steam-Producing Value of Coals from a Preliminary Examination. William Thompson. Read before the Can. Elec. Assn. Discusses a method whereby the heating power, and consequently the value of any fuel, can readily be determined. 2500 w. Can Elec News—June, 1897. No. 13478.

INUNDATION.

The River Level Colliery Inundation. Offi-

cial reports of J. T. Robson and Robert Woodfall on the circumstances attending the inundation which took place at Abernant, December 9, 1896. 2400 w. Col Guard—June 11, 1897. No. 13615 A.

MACHINERY.

Electric Mining Machinery. Fred J. Platt. Read before the Anthracite Coal Operators' Assn. Some facts in regard to its successful use, efficiency, superiority over old methods, its adaptability to various portions of the workings, and the comparative cost of operation. 4000 w. Col Eng—June, 1897. No. 13606 C.

MACHINE Mining.

Machine Coal Mining in Iowa, U. S. A. Foster Bain. Read before the Federated Institution of Mining Engineers. Describes methods of mining and machines used. 3300 w. Col Guard—June 11, 1897. No. 13614 A.

POT-HOLES.

Pot-Holes and the Mt. Lookout Cave. William Griffith. Read at the annual meeting of the Anthracite Coal Operators' Assn. Describes the formation, and the mine accidents caused by these phenomena. 1700 w. Eng News—June 24, 1897. No. 13685.

PRODUCTION.

United States Coal Production in 1896. Tables giving statistics of the total production of coal and coke in the United States for 1896, as collected for *The Mineral Industry*, with comments. 1800 w. Eng & Min Jour—June 19, 1897. No. 13492.

SPONTANEOUS Combustion.

Spontaneous Combustion of Coal Cargoes. Conclusion of the Royal Commission appointed by the Government of New South Wales to inquire into the causes of the firing of coal cargoes, as given in their report. 1300 w. Aust Min Standard—May 13, 1897. No. 13720 A.

TRANSVAAL.

Notes on the Coal Seams of the Transvaal, and Description of a Modern Pit-Head Plant. W. T. Hallimond. Describes the conditions under which the seams are found, and the plant erected at the Rand Collieries. 1600 w. Ir & Coal Trds Rev—June 18, 1897. No. 13728 A.

UNDERGROUND Fire.

Underground Fire at Bridgewater Colliery. A. Dury Mitton. Read before the Federated Institution of Mining Engineers. Describes the conditions and the mode of conquering the fire, with the difficulties. 2800 w. Col Guard—June 11, 1897. No. 13613 A.

COPPER.

ARSENIC.

Notes on the Estimation of Arsenic in Copper. George L. Heath. Suggestions concerning a method, from the writer's experience found suited to high-grade refined metal. 1000 w. Eng & Min Jour—June 26, 1897. No. 13692.

COPPER.

Tools and Weapons of the Age of Pure Copper in Egypt. (Outils et Armes de l'Age du Cuivre Pur en Egypte.) An interesting communication by M. Berthelot concerning the chemical analysis of some very ancient tools, with surmises as to the method of their production. 2500 w. Comptes Rendus—May 24, 1897. No. 13554 D.

METAL Mines.

Characteristic American Metal Mines. Titus Ulke. Describing the Anaconda copper mine and works. Ill. 4600 w. Eng Mag—July, 1897. Serial. 1st part. No. 13805 B.

NICKEL.

Modern American Nickel Refining. Titus Ulke, in the *Zeitschrift fur Electro chemie*. Consideration of the methods in use, which are claimed to be superior to the European methods. Abstract with diagrammatic scheme of the Orford method of treating nickel-copper matte. 1800 w. Eng & Min Jour—July 3, 1897. No. 13823.

GOLD AND SILVER.

ARIZONA.

The Fortuna Gold Mine, Arizona. William P. Blake. Description of mine and manner of working 1200 w. Eng & Min Jour—June 26, 1897. No. 13693.

The Mines of Yavapai County, Arizona. John P. Blandy. Descriptive account of the mineral wealth of this district. Map. 2600 w. Eng & Min Jour—June 19, 1897. No. 13495.

The Pearce Mining District, Arizona. F. M. Endlich. Describes this rich mine, and the interesting conditions surrounding it. 1100 w. Eng & Min Jour—June 5, 1897. No. 13276.

BLACK Hills.

The Metallurgy of the Refractory Gold Ores of the Black Hills of South Dakota. Frank Clewes Smith. Brief review of the source of these ores, their discovery and process of treatment. 3400 w. Technic—1897. No. 13767 D.

COLOMBIA.

Explorations in the Gold Fields of Western Colombia. F. C. Nicholas. Read before the N. Y. Academy of Sciences. Investigations of the country leading the writer to believe that the general deposits of gold are not one-tenth part of what might be expected from the reports of certain findings, but due to the gold becoming concentrated in depressions and along zones of drainage. 3300 w. Sch of Mines Quar—April, 1897. No. 13455 D.

COLORADO.

Some Mineral Veins of Gunnison County, Colorado. E. R. Warren. Describes veins that may become of considerable economic value. The ores are usually a mixture of galena blende and pyrite, with some silver and gold. 1500 w. Eng & Min Jour—June 12, 1897. No. 13405.

CYANIDING.

Cyaniding Gold Ores. H. Rosales. Explains the nature of cyanogen and of cyanide of potassium, their value and adaptability as solvents of gold from auriferous ores, and describes in detail the method and treatment. 8400 w. Aust Min Stand—April 22, 1897. No. 13340 A.

Precipitation of Gold from Cyanide Solutions. L. Ehrmann. From Trans. Chem. and Met. Soc, Johannesburg. Describes experiments made giving results. Discussion follows. 2500 w. Min & Sci Pr—June 19, 1897. No. 13707.

EXTRACTION.

The Extraction of Gold from Kalgoorlie Ores. Walter J. Studds. A comparison of percentage

extraction and cost by smelting with that by battery amalgamation, concentration, and cyanidation. 2000 w. Aust Min Stand—April 29, 1897. No. 13341 A.

FISSURE Veins.

Filling and Replacement in Gold-Bearing Fissure Veins. Waldemar Lindgren. Considers the alterations of the country rock in and near the fissure veins, the silicification, and the structure of the veins. 1600 w. Eng & Min Jour—June 5. 1897. No. 13277.

GEORGIA.

The Cartersville Mining District, Georgia. William M. Brewer. A brief account of this district and the diversity of the mineral resources. 1000 w. Eng & Min Jour—June 5. 1897. No. 13278.

GOLD Field.

The Disputed Gold District of Brazilian Guiana. (Der Strittige Golddistrict von Brasilianisch Guyana.) A geographical and geological description, by Dr. Katzer, of Para. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 29, 1897. No. 13577 B.

The Lake of the Woods Gold-Field. T. A. Rickard. Discovery, prospecting, history, geology, gold-bearing veins, &c., are described. Ill. 3300 w. Eng & Min Jour—July 3, 1897. No. 13822.

ORE-Shoots.

Ore-Shoots of Cripple Creek. Arthur Lakes. Treats of their appearance, nature and shape, and how they differ from veins. Describes the peculiarities in some of the mines of Raven Hill, Gold Hill, Bull Hill, Battle Mountain and Beacon Hill. Ill. 2300 w. Col Eng—June, 1897. No. 13605 C.

PLACER Deposits.

Placer Prospecting. Arthur Lakes. Notes and suggestions for those starting to prospect for placer deposits. Ill. 5000 w. Col Eng—June, 1897. No. 13603 C.

RECEPTACLES.

Receptacles for Valuable Mineral Deposits. A study of receptacles and the importance to the miner in understanding how to work any deposit. 6000 w. Aust Min Stand—April 29, 81897. Serial. 1st part. No. 13342 A.

IBERIA.

Working Frozen Alluvial Deposits in Siberia. E. D. Levat. Describes the special methods of working where the ground is always frozen. Ill. 900 w. Eng & Min Jour—June 12, 1897. No. 13406.

SILVER-LEAD.

Heat Requirements of the Silver-Lead Blast Furnace. L. S. Austin. Investigation of this subject. 1000 w. Eng & Min Jour—June 19, 1897. No. 13496.

THE CAROLINAS.

The Genesis of the Gold Ores in the Central Slate Belt of the Carolinas. H. B. C. Nitze. Considers the structure of the deposits, the causes of the formation of the spaces occupied by the deposits, and the manner of filling these spaces. 2200 w. Eng & Min Jour—June 19, 1897. No. 13493.

VICTORIA.

The Steiglitz Goldfield, Victoria. William Bradford. Illustrated detailed description. 2000 w. Aust Min Stand—May 13, 1897. Serial. 1st part. No. 13719 A.

WITWATERSRAND.

The Witwatersrand Gold-Field and its Working. L. de Launay. Part first deals with the geology of the gold-field. giving maps and sections. 1300 w. Eng & Min Jour—June 19, 1897. Serial. 1st part. No. 13494.

IRON AND STEEL.

ALABAMA.

See same title under Coal and Coke.

ANALYSIS.

The Gas Volumetric Determination of Carbon in Iron and Steel. (Zur Gasvolumetrischen Bestimmung des Kohlenstoffes in Eisen und Stahl.) Describing an improved apparatus used in the laboratory of the technical High School at Brünn. 1 Plate. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 22, 1897. No. 13576 B.

CARBIDE.

Preparation of Carbide of Iron by the Direct Union of the Metal and Carbon. (Préparation du Carbure de Fer par Union Directe du Métal et du Carbone.) A communication by M. Moissan showing the conditions under which carbide of iron is produced in the electric furnace. 3000 w. Comptes Rendus—April 5, 1897. No. 13549 D.

CARBON.

Forms of Carbon, and the Hardening of Steel. (Kohlenstoff formen und Stahlhärtung.) Discussing the formation of Carbide of iron in connection with the hardening of steel. 2000 w. Stahl und Eisen—June 1, 1897. No. 13563 D.

CAST Iron.

See Mechanical Engineering, Shop and Foundry.

CHINA.

Iron Mines in China. Reprint of an article from the *North China Daily News*, giving a description of the iron and coal mines near Hankow, in Hupeh, of interest to those concerned in the railroad development of China. 1800 w. Cons Repts—June, 1897. No. 13649 D

CONVENTIONS.

Convention of the Eisenhüttenleute, and of the Iron & Steel Institute. (Die Haupt Versammlung des Vereins Deutscher Eisenhüttenleute und die Versammlung des Iron & Steel Institut.) A general report, from the German standpoint, of these two great conventions, with valuable tables and data. Two articles. 12000 w. Glückauf—June 5 & 12, 1897. No. 13583 E.

ELASTICITY.

The Elasticity of Steel. H. K. Landis. The main purpose of the paper is to point out an important error in the methods of determination of quality. 1800 w. Am Mfr & Ir Wld—June 18, 1897. No. 13647.

GRADING.

The Grading of Southern Coke and Charcoal Iron. The purpose of the paper is to point out the fallacies and show wherein the present system of grading, as practiced, lacks the uniformity and exactness which should be expected, and to urge the necessity of a standard based on chemical inspection. 1800 w. Tradesman—June 15, 1897. Serial. 1st part. No. 13607.

HIGH Temperatures.

Relation of Carbon to Iron at High Temperatures. Results from experiments made in the metallurgical department of Mason College, Birmingham, as given in a paper by G. P. Royston, read before the British Iron and Steel Inst. 700 w. Am Mfr & Ir Wld—June 25, 1897. No. 13723.

IRON-ORE.

Notes on the Iron-ore Resources of Different Countries. Part first gives an illustrated account of the resources of the United States. 1600 w. Ir & Coal Trds Rev—May 28, 1897. No. 13355 A.

ORDNANCE.

Iron and Steel for Ordnance. Facts taken from a paper read some years ago by Capt. Scott, before the Royal United Service Institution. Ill. 3600 w. Sci Am Sup—June 26, 1897. No. 13673.

MAGNETISM.

The Magnetic Properties of Modern Irons. (Ueber die Magnetischen Eigenschaften der Neueren Eisensorten.) Discussing the applicability of the Steinmetz coefficient to various commercial brands of iron. 3500 w. Stahl und Eisen—June 1, 1897. No. 13564 D.

The Steinmetz Coefficients of Magnetic Hysterisis. (Ueber den Steinmetz'schen Koefficienten der Magnetischen Hysteresis.) Applying the Steinmetz coefficients to a variety of modern irons. 3500 w. Elektrotechnische Zeitschr—May 13, 1897. No. 13570 B.

MICROSCOPICAL Examination.

Microscopical Examination of Iron and Steel. Albert Sauveur. Part first reviews the use of the microscope as an instrument of research in metallurgy, and the problems to be solved by chemical and microscopic examination. 2500 w. Eng & Min Jour—June 26, 1897. No. 13691.

NEW Works.

The New Works of the Apollo Iron & Steel Company. Illustrated detailed description of a model plant, possessing many features of novelty. 3000 w. Ir Age—June 17, 1897. No. 13458.

NICKEL Steel.

Investigations upon Nickel Steel. (Recherches sur les Aciers au Nickel.) Giving an account of the properties of an alloy of nickel and steel which has a very low coefficient of expansion besides other properties which make it especially adapted for standards of length. 1200 w. Comptes Rendus—April 5, 1897. No. 13550 D.

OPEN HEARTH Steel.

Combined Open Hearth Steel Manufacture. Benjamin Talbot. Description of process with results and impressions gained by practical experience in its use. 1800 w. Ir Age—June 17, 1897. No. 13457.

The Siemens and Siemens-Martin Processes. History of the development and the difficulties encountered, the changes and improvements in the methods of manufacture, changes in cost, &c. 3800 w. Ir & Coal Trds Rev—June 18, 1897. No. 13729 A.

ORE Supplies.

On the Iron Ore Supplies Available for the British Iron Trade. Josiah T. Smith. Paper read before the recent conference of the British Iron Trade Assn. Discusses the extent to which home supplies may be further utilized, and the sources of cheap and suitable ores from various countries. 3000 w. Ir & Coal Trds Rev—June 18, 1897. No. 13730 A.

SCANDINAVIA.

The Scandinavian Iron Ore Beds. (Ueber die Bildung der Skandinavischen Eisenerzlager.) A review, by Prof. Vogt of Christiania, of the geological and mineralogical conditions of the iron ore beds of the Scandinavian Peninsula. 5000 w. Glückauf—June 5, 1897. No. 13582 B.

SLAG.

Nitrosylized Blast Furnace Slag as an Addition to Hydraulic Cement. A. D. Elbers. Information regarding the efficiency and the treatment. 1300 w. Eng & Min Jour—June 26, 1897. No. 13690.

STEEL.

Steel as Viewed by the Engineer. P. Kreuzpointner. Discusses quality of structural steel, and methods of testing and inspection. Also discussion. 8800 w. Pro Engs' Club of Phila—April, 1897. No. 13335 D.

The Bertrand-Thiel Process. (Der Bertrand-Thiel Process.) A paper by Herr Thiel before the Düsseldorf Convention with an active discussion by various members. 8000 w. Stahl und Eisen—May 15, 1897. No. 13561 D.

The Bessemer Process. (Der Bessemer Process.) A review of the present status of the Bessemer process, presented at the Düsseldorf Convention by Herr Malz. 2500 w. Stahl und Eisen—May 15, 1897. No. 13559 D.

The Martin Process. (Der Martin Process). With details of gas producers, and a general account of present open hearth steel methods. By Herr Springorum, at the Düsseldorf Convention. 3500 w. Stahl und Eisen—May 15, 1897. No. 13560 D.

The Thomas Process. (Thomas Process.) A paper giving a general résumé of the Thomas Steel process, read by Herr Kintzlé at the Düsseldorf meeting of the Eisenhüttenleute. 6000 w. Stahl und Eisen—May 15, 1897. No. 13558 D.

STEEL Plates.

Witkowitz Steel Plates. A report of trial of these plates and the verdict, with observations and criticism. 2200 w. Eng, Lond—June 18, 1897. No. 13731 A.

STEEL Works.

Pittsburg Works of the Fox Pressed Steel Equipment Co. Illustrated detailed description of new works which are said to be the finest and most complete of their kind in this country. 1500 w. Ry Rev—June 5, 1897. No. 13296.

TIN PLATE.

The Tin Plate Industry in the United States. Ira Ayer. An account of the rapid growth of this industry since 1890, and much interesting information concerning the difficulties met and conquered. Also a tabulated statement of production in the United States, for each year since 1892. 6500 w. Jour Fr Inst—June, 1897. No. 13285 D.

VANADIUM.

The Alloys of Vanadium. (Les Alliages de Vanadium.) An account of the process of M. Helouïs for the production of an alloy vana-

dium. aluminium and sodium, for use in the metallurgy of iron and steel. 1000 w. La Revue Technique—May 25, 1897. No. 13548 D.

WROUGHT Iron.

Wrought Iron and Mild Steel. A. Humboldt Sexton. Discusses what is malleable iron, and what is mild steel, their points of resemblance and difference, why mild steel has so largely displaced iron, and why iron is still preferred for some purposes. 5500 w. Prac Eng—June 18, 1897. No. 13740 A.

MINING.

ADDRESS.

Presidential Address of Mr. Lindsay Wood. Address before the Federated Institute of Mining Engineers, London. Discusses the influence of mining and engineering institutes, the advancement made in the science of mining, etc. 4300 w. Ir & Coal Trds Rev—June 4, 1897. No. 13402 A.

COMPRESSED AIR.

See "Mining" under Mechanical Engineering, Compressed Air.

DEEP Shafts.

The Deepest Shafts in the Earth. (Die Tiefsten Schächte der Erde.) Giving a table of the notably deep shafts in various parts of the world. 600 w. Glückauf—May 22, 1897. No. 13580 B.

MINING.

Papers Read at the Engineering Conference in London. "Dealing with Water in Pits during Sinking and in Permanent Work," by John Bell Simpson; "Water in Deep Shafts," by Henry Davey; "On Deep Levels in Mining Practice in the United Kingdom," by Bennett H. Brough; and "The Kent Coal-field," by Robert Ethridge. 5500 w. Col Guard—May 28, 1897. No. 13315 A.

MISCELLANY.

ASPHALTITES.

The Uinta and the Uncompahgre Asphaltites of Utah. Extracts from monograph on these deposits by George Homans Eldridge, in the report of the Geological Survey are given, with remarks. 2500 w. Eng & Min Jour—July 3, 1897. No. 13824.

LADDERS.

The Strength of Ladders. Robert Gilman Brown. Describes tests made of ladders of the common "Bull" pine of the Sierra region. 800 w. Eng & Min Jour—June 12, 1897. No. 13408.

MAPPING.

Mining Maps for Working Use. (Grubenkarten für Erzbergbane.) A discussion of the proper surface and underground maps, with especial reference to the conditions of the Hungarian mines. Two articles. 8000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 1 & 8, 1897. No. 13575 E.

PETROLEUM.

The Petroleum Fields of Roumania. (Les Pétroles de Roumania.) A description of the petroleum fields as yet very imperfectly worked or developed, with some account of the geological formation in which they occur. 1500 w. La Revue Technique—May 10, 1897. No. 13539 D.

RUBY MINES.

The Ruby Mines of Burma. T. Trafford Wynne. Extract from a paper recently read before the Institution of Mining and Metallurgy in London, giving account of climate, labor, formation, exploitation, and methods of mining. 2000 w. Eng & Min Jour—June 12, 1897. No. 13407.

TIN.

The Tin Deposits at Temescal, Southern California. Harold W. Fairbanks. Describes the geology of the district, the vein system and tin deposits. 1700 w. Am Jour of Sci—July, 1897. No. 13771 D.

Tin Mining in Tasmania. H. W. Ford Keyser. Abstract of a paper presented to the general meeting of the Federated Institution of Mining Engineers. Part first gives the early history of tin mining in Tasmania. 3300 w. Ind & Ir—June 11, 1897. Serial. 1st part. No. 13620 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ADDRESS.

Inaugural Address of C. Stafford Ellery, before the Incorporated Gas Institute at Bath, Eng. The address deals largely with local matters, presents the value of chemistry in the gas industry, discusses carburetted water gas, and the amount of light that can be obtained from a ton of coal by different methods, &c. 7500 w. Gas Wld—June 19, 1897. No. 13784 A.

ATMOSPHERIC Burner.

The Theory of the Atmospheric Burner, and Its Influence upon Incandescent Gas Lighting. Vivian B. Lewes. Experiments with results of researches into the phenomena of the Bunsen burner. Read before the Incorporated Gas Inst. at Bath. 7500 w. Gas Wld—June 19, 1897. No. 13788 A.

BENZOL.

Benzol and Its Value as an Illuminating Agent. (Das Benzol und Seine Bedentung als Leuchtstoff.) Discussing especially the value of benzol as an enriching material for poor gases. 6000 w. Glückauf—May 15, 1897. No. 13579 B.

The Importance of Benzol as an Illuminant. Dr. Kramer. Abstract of a communication to the Verein fur Gewerbefleiss. Discusses the recovery and purifying of benzol, and its value as an illuminant. 2400 w. Jour of Gas Lgt—June 22, 1897. No. 13775 A.

CALORIMETER.

The Junker Calorimeter. (Calorimètre Industriel Junkers.) An illustrated description of the Junker Calorimeter, by means of which the calorific power of a gas to be used for heating, or in a gas engine, may be readily and accurately

determined. 1200 w. Le Genie Moderne—June 1, 1897. No. 13538 B.

CARBURINE.

On Three Years' Use of Carburine as an Enricher. Joseph Davis. Read before the Incorporated Gas Inst. at Bath, Eng. Results of experience during the last three years in working the Maxim-Clark process. Describes apparatus and method of working it. Also discussion. 8000 w. Gas Wld—June 19, 1897. No. 13790 A.

DISTRIBUTION.

Gas Distribution in Relation to Modern Municipal Development. Thomas Canning. Read before the Incorporated Gas Inst. at Bath, Eng. Discusses the size of mains, the precautions necessary in view of the newer condition of street paving, electrolysis of gas pipes, &c. 4800 w. Gas Wld—June 19, 1897. No. 13794 A.

FLAMES.

Explosion Flames. Harold B. Dixon. Abstract of a lecture at the Royal Institution. Reviews the work of others and gives an account of his own experiments. 3000 w. Jour Gas Lgt—May 25, 1897. No. 13283 A.

The Cause of Luminosity of Hydrocarbon Flames. Wilfrid Irwin. Read at meeting of the Manchester Section of the Society of Chemical Industry. Combats Prof. Lewes' ideas, and gives experiment illustrating his own. 1600 w. Jour of Gas Lgt—June 15, 1897. No. 13677 A.

FUEL GAS.

Fuel Gas. Arthur Kitson. Discusses the methods of converting solid and liquid into gaseous fuel, cost, &c. 5000 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13665 D.

On Cooking by the Aid of Gas, and the Ventilation of Kitchens. William Sugg. Read at meeting of Incorporated Gas Inst. at Bath, Eng. Historical retrospect, with the advantages of use of gas in cooking. Discussion. 6000 w. Gas Wld—June 19, 1897. No. 13786 A.

The Failure of the Commercial Attempts to Supply Fuel Gas in the United States. F. H. Shelton. Read before the Western Gas Assn. A paper proposing to show that fuel gas as a whole in every case where tried has been a flat and total failure. Gives a brief account of all instances where it has actually been made and distributed in this country. Discussion. 21000 w. Am Gas Lgt Jour—June 7, 1897. No. 13345.

GASHOLDER.

Notes on the Construction, and Experience in the Working, of the Gadd and Mason Spiral-Guided Holder at the Chester Gas Works. Robert Hunter. Read before the Incorporated Gas Inst., at Bath, Eng. A statement of reasons for adopting this holder, and experiences in its working during the past four years. 2700 w. Gas Wld—June 19, 1897. No. 13787 A.

The Inversion of an Untrussed Gasholder Crown. An account of an interesting operation in gasholder construction now in progress at the South Metropolitan Gas Company's Old Kent Road Station. 1700 w. Jour of Gas Lgt—June 15, 1897. No. 13676 A.

The Large Treble Lift Gasholder at the Bradford Road Gas Works, Manchester, Eng. Illustrated description. 800 w. Jour Gas Lgt—June 8, 1897. No. 13465 A.

INCANDESCENT Gas Lighting.

The Theory of Incandescent Gas Lighting. Abstract translation of an article by Dr. Moscheles, published in the "Zeitschrift für Beleuchtungwesen," on the cause of the intense development of light by Welsbach mantles in a gas flame. 1000 w. Jour Gas Lgt—June 1, 1897. No. 13350 A.

INCLINED Retorts.

An Additional Chapter on Inclined Retorts. Frederick Egner. Information concerning results with the sloping retorts. 2400 w. Am Gas Lgt Jour—June 21, 1897. No. 13627.

LEAKAGE.

Leakage. E. H. Jenkins. Read before the Western Gas Assn. Careful consideration of the subject, followed by discussion. 11000 w. Am Gas Lgt Jour—June 14, 1897. No. 13433.

MEASUREMENTS.

Calibration of a Pitot Tube in Gas Measurements. Forrest M. Towl. Illustrated description of tests and manner of using the tube, with tables. 1600 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13668 D.

MUNICIPALIZATION.

Is the Municipalization of Gas Undertakings Advantageous? Herbert Lees. Read before the Incorporated Gas Inst., at Bath, Eng. Concludes that under present circumstances it is not to the advantage of the consumer. Discussion. 9500 w. Gas Wld—June 19, 1897. No. 13793 A.

NAPHTHALENE.

Naphthalene in Modern Gas Manufacture, and the Carburetting of Illuminating Gas, William Young and Thomas Glover. Read before the Incorporated Gas Inst. at Bath, Eng. An account of the methods hitherto employed in reference to naphthalene, and an account of the new methods devised by the authors. 4500 w. Gas Wld—June 19, 1897. No. 13789 A.

PRESSURE Regulation.

The Automatic Regulation of Pressure in the Distributing Mains. William Reginald Chester. Read before the Incorporated Gas Inst., at Bath, Eng. Describes the apparatus invented by William Cowan and the satisfactory working. Discussion. 6500 w. Gas Wld—June 19, 1897. No. 13791 A.

PURIFICATION.

On Experiments with the Claus System of Purification at Belfast. James Stelfox. Read before the Incorporated Gas Inst., at Bath, Eng. Reports the trial of the system on a large scale and the failure. Discussion. 8800 w. Gas Wld—June 19, 1897. No. 13785 A.

STREET Lighting.

The Welsbach Incandescent Gas Light for Utility and Economy in Street Lighting. H. Wilkiemeyer. Read before the Western Gas Assn. Report of the success attained, with discussion and correspondence. 7000 w. Am Gas Lgt Jour—June 14, 1897. No. 13434.

TAXATION.

The Taxation of Gas by Local Authorities. Isaac Carr. Read before the Incorporated Gas Inst., at Bath, Eng. On the system of applying gas profits to the relief of local rates. 3300 w. Gas Wld—June 19, 1897. No. 13792 A.

SEWERAGE.

INFILTRATION.

Infiltration of Ground Water into Pipe Sewer Systems. Prepared from a Thesis by F. S. Senior. An attempt to throw some light in an experimental way, upon the question of what is a fair amount of infiltration to be expected from the joints of sewer pipe laid in water, before the cement has well set. 3500 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13671 D.

PRECIPITATION.

Excessive Precipitation in the United States. Alfred J. Henry. Extract from the "Monthly Weather Review," Jan. 1897. Valuable table of facts concerning excessive rain during 1896 with other information. 1500 w. Eng News—June 24, 1897. No. 13681.

PURIFICATION.

The Purification of Waste Water. (Mittheilung über die Reinigung der Fabriks-Abwässer.) Describes simple form of sedimentation, purification and filtration plant, by means of which the discharge water from manufacturing establishments may be purified before discharge into streams. 1 plate. 2500 w. Oesterr Monatschr f d oeffent Baudienst—May, 1897. No. 13526 D.

SEWERAGE.

The Best Method of Sewage Disposal on Farms and in Small Communities. B. C. Brett, in the *Medical Age*. Suggestions easily carried out at small cost, and, with proper attention, insuring health and cleanliness. 2200 w. Sci Am Sup—June 26, 1897. No. 13674.

The Paris Sewage System. (Die Entwässerung von Paris.) A discussion of the Paris sewers in comparison with those of Berlin, especially with regard to the sewage farms. Two plates. 8000 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13521 D.

The Sewers of Paris, and the Purification and Utilization of the Sewage. (Die Kanalisirung von Paris, soure die Reinigung und Benutzung des Kanalwassers.) Especially describing the recent work in connection with the sewage utilization at Gennevilliers, Clichy and Achères. 4500 w. Glaser's Anna en—May 15, 1897. No. 13512 D.

SEWER Joints.

The Effect of Imperfect Joints upon the Flow in Pipe Sewers. Prepared from a Thesis by G. D. Holmes. Experiments made with six-inch vitrified tile pipe, showing generally an increase of velocity with the smooth interior. 2500 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13670 D.

SEWER Pipe.

Notes on the Construction of Pipe Sewers. H. E. Riggs. On methods of construction, mode of handling certain perplexing problems and pipe laying. 4300 w. Technic—1897. No. 13763 D.

Sewer Pipe Tests. Charles E. Greene Describes tests made and gives results and conclusions. 1600 w. Technic—1897. No. 13761 D.

STREETS AND PAVEMENTS.

SIDEWALKS.

Specifications for Cement Sidewalk Construction. A. J. McPherson, in Journal of the Engineering Society of the School of Practical Science of Toronto. Abstract of specification. 800 w. Eng News—June 24, 1897. No. 13680.

WOODEN Pavement.

Wooden Pavement and Public Health in Paris. Describes the construction and comments on the sanitary excellence. 1400 w. San Rec—June 11, 1897. No. 13624 A.

WATER SUPPLY.

ARTESIAN Wells.

Artesian Tube Wells. J. E. Discusses the work of tube lining and subsequent discharge. Ill. 1800 w. Ind Engng—May 15, 1897. No. 13476 D.

BIRMINGHAM, Eng.

The New Birmingham Water-works. From the *Birmingham Daily Post*. Describes a visit of inspection made by the City Council to these extensive works, now in process of construction. 2700 w. Arch, Lond—June 11, 1897. No. 13639 A.

CONSUMPTION.

Notes on Water Consumption. G. S. Williams. A study of the consumption in an American city considering the statistics mainly with reference to the quantity of water that must be provided at various times. 4000 w. Technic—1897. No. 13760 D.

DRILLED Well.

An Experience with a Drilled Well Adjoining Salt Water. James S. Haring. An account of an effort to obtain a new water supply, near Nyack, N. Y. The tests are given and the failure explained. 2000 w. Fire & Water—June 19, 1897. No. 13600.

FILTER Cleaning.

The Cleaning of the Open Filters at Hamburg in Time of Frost. (Die Reinigung der Hamburger Offenen Sandfilter in der Frostzeit.) An illustrated description of the Mager Scoop, by means of which the Hamburg filter beds are effectively cleaned when covered with ice. 6000 w. Gesundheits Ingenieur—May 31, 1897. No. 13532 B.

FILTRATION.

Increased Revenue, Free Service Pipes and Filtration. Dow R. Gwinn. Read before the convention of the American Water Works Assn. Describes the inducements offered to obtain customers, the manner and cost of laying service pipes, and the advantages of filtration. 1800 w. Fire & Water—June 12, 1897. No. 13432.

LONDON.

The London Water Supply. Percy F. Frankland. Extracts from a paper read before the Society of Arts. The value of bacteriology to the water engineer, an account of recent investigations in this field and the information collected, with special reference to the London supply. 4800 w. Jour of Gas Lgt—June 22, 1897. No. 13776 A.

METERS.

Value of Meters in Restricting Waste. L. N. Case. Extracts from address before the senate committee of the Michigan legislature to oppose the passage of the "free water bill." 1500 w. Fire & Water—June 26, 1897. No. 13733.

PUMPING Engine.
See Mechanical Engineering—Engines and Motors.

PURIFICATION.
Purification of Water by Metallic Iron. C. W. Chancellor. A report of the iron process from the consul at Havre. 2400 w. Am Arch—June 5, 1897. No. 13359.

RESERVOIR.
The New Highland Reservoir, No. 2, Pittsburg, Pa. Plans and description of new reservoir built to save the expense of pumping the whole supply to unnecessary height, and to decrease the wear and tear on the mains. 1200 w. Eng Rec—June 19, 1897. No. 13,498.

SANITARY Sources.
Some of the Important Water Supplies of Europe Considered Mainly from a Sanitary Standpoint. James H. Fuertes. Interesting statistics concerning the water supplies of many European cities. 5700 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13664 D.

TOWNS.
Towns Water Supply and Its Distribution. W. M. Watson. The duty of supplying an abundance of good water, and many suggestions relating to the construction and care of the water supply. 4200 w. Can Eng—June, 1897. No. 13279.

TUNNEL.
Description of the Construction of the New Chicago Waterworks Tunnel. William G. Atwood. The building of a ten-foot tunnel, four miles into the lake. 2200 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13669 D.

TYPHOID Fever.
The Water Supplies of Eight Cities in Relation to Typhoid Fever Rates. John W. Hill. An address before the Soc. of Municipal Improvements, Chicaco, Ills., Oct. 9, 1896. Facts concerning four well-known cities of Europe and four well-known cities of the United States. 4400 w. San—June, 1897. No. 13451 D.

WATER Fermentation.
The Causes and Prevention of Water Fermentation. Samuel McElroy. Discussing the problem in the light of Brooklyn's experience with her water supply. 3300 w. Eng Mag—July, 1897. No. 13806 B.

MISCELLANY.

ABATTOIR.
The New Paris Abattoir. (Das Neue Schlachthaus der Stadt Paris.) A bird's-eye view and description of the new abattoir on the left bank of the Seine. About 25 acres of ground are included, and the abattoir has a capacity for about one-third the entire demand of the city. 1 plate. 1000 w. Oesterr Monatschr f. d Oeffent Baudienst—June, 1897. No. 13527 D.

LIGHTING.
Artificial Lighting. George D. Shepardson. An outline of the history of lighting with a study of illumination. 6500 w. Jour Assn of Engng Soc—May, 1897. No. 13663 C.

Municipal Lighting in the United States. F. W. Cappelen. Read at the meeting of Engineers' Club of Minneapolis. Information obtained from replies to a set of sixty-six questions sent out by a committee, with a few suggestions as to the best method of street lighting. 3500 w. Jour Assn of Engng Soc—May, 1897. No. 13662 C.

STREET Railways.
See "Municipal Ownership," under Street and Electric Railways.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

ASSAM-BENGAL.
Construction Work on the Assam-Bengal Railway. Francis Robert Johnson. Remarks referring to the section from Chittagong to Badarpur, the difficulties of construction being mentioned, but principally descriptive of the bridge work. 2000 w. Eng, Lond—June 11, 1897. Serial. 1st part. No. 13616 A.

BEHR System.
The Behr Monorail System. Brief history of the monorail systems, with description of the permanent way of the Behr system at Tervuren. Ill. 1800 w. Engng—June 11, 1897. Serial. 1st part. No. 13611 A.

CHINA.
Siberian Railway Extension in China. Information regarding the construction and working of the new line, which will give nearly 950 miles in Chinese territory. 2000 w. Eng, Lond—June 4, 1897. No. 13411 A.

ETNA.
The Circum-Etna Railway. Illustrated description of the railway round Mount Etna. 500 w. Eng, Lond—May 28, 1897. No. 13317 A.

INCLINE.
The Madison Hill Incline; P., C., C. & St. L. Ry. Edward Grafstrom. Historical sketch on the origin and development of engineering on the Madison Hill at Madison, Ind. Ill. 3600 w. Eng News—June 10, 1897. No. 13374.

LIGHT Railways.
Proposed Construction of Light Railways in Germany. Brief history of light railways to the present time with abstract of the new bill for the extension of the system. 900 w. Bd of Trd Jour—June, 1897. No. 13694 A.

VENEZUELA.
The Great Venezuela Railway. (Die Grosse Venezuela Eisenbahn.) The road, 112 miles long, between Caracas and Valencia, was constructed with great difficulty, mainly by German engineers and capital, at a cost of about $15,000,000. A full account of the engineering work is given. 7500 w. Glaser's Annalen—May 15, 1897. No. 13510 D.

MAINTENANCE OF EQUIPMENT.

BOX Car.
The Framing of a Box Car. George L. Fowler. An analysis of the stresses and their

distribution through the framing of a box car. 2200 w. R R Car Jour—June, 1897. No. 13362.

BRAKE.

The Westinghouse High-Speed Brake. Illustrated description. 2000 w. R R Gaz—June 25, 1897. No. 13700.

CAR.

The Schoen Steel Car. Brief description with illustrations. 800 w. R R Gaz—June 25, 1897. No. 13702.

CAR Heating.

Improvements in Steam Heating of Passenger Carriages on the Prussian Railways. (Neuere Anordnungen für die Dampfheizung der Personenwagen bei den Preussischen Staats-Eisenbahnen.) The improved system permits of moderate heating in mild weather or full heating in cold weather, with control of each compartment by the passengers. 6000 w. 1 plate. Glaser's Annalen—June 1, 1897. No. 13513 D.

CAR Lighting.

Electric Car Lighting from the Axle. Illustrated description of the construction and application of the system of direct cog wheel gearing from the axle to the dynamo. 900 w. Ry Rev—June 5, 1897. No. 13297.

The Electric Lighting of Railway Carriages. (Ueber Elektrische Beleuchtung von Eisenbahn Personenwagen.) A very thorough paper by Dr. Buettner, giving comparative results as to the cost of electricity as opposed to gas. 8000 w. Glaser's Annalen—May 15, 1897. No. 13511 D.

COAL Car.

Double Hopper 100,000-lb. Coal Car—Michigan Peninsular Car Co. Illustrated detailed description. 1200 w. Ry Rev—June 5, 1897. No. 13295.

COMBINATION Car.

Combination Passenger and Baggage Cars—Baltimore & Ohio. General dimensions and cuts showing in detail the framing and sections of first-class combination passenger and baggage cars. 1000 w. R R Gaz—June 4, 1897. No. 13307.

COUPLERS.

Uncoupling Arrangements for M. C. B. Automatic Couplers. Report from the committee, submitted at the Master Car Builders' Convention at Old Point Comfort. Ill. 1000 w. Ry Rev—June 19, 1897. No. 13658.

ERIE'S Train.

The Erie's New Through Train. Brief illustrated description of a fine train recently put in service on this road. 600 w. Loc Engng—June, 1897. No. 13331 C.

FIRE-BOX.

Locomotive Firebox Design. R. P. C. Sanderson. Personal experiences which have brought the subject before the writer's notice, with search for causes and knowledge gained. 3000 w. R R Gaz—June 11, 1897. No. 13381.

GONDOLA Car.

An Improvement in Gondola Car Construction. Diagrams showing a new method for the construction of gondola, coal, coke and other cars, where the sides are supported by stakes, now placed outside the sills. 600 w. Ry Mas Mech—June, 1897. No. 13272.

LOCOMOTIVES.

Experiments on a Compound Locomotive. Summarized translation by Bryan Donkin, from *Revue Générale des Chemins de Fer.* Dynamometric experiments on a four-cylinder express compound locomotive on the Paris, Lyons, and Mediterranean Railway, made by M. Privat in 1895. 1800 w. Engng—June 18, 1897. No. 13712 A.

Locomotive Improvement. Leonard J. Todd. Presents the advantages of the "dual exhaust" cylinder and claims a saving of 10 per cent. could be gained. 3000 w. Eng, Lond—May 28, 1897. No. 13320 A.

New Ten-wheel Passenger Locomotive—Louisville Division, Illinois Central. Illustrated description with dimensions. 800 w. R R Gaz—July 2, 1897. No. 13817.

Some Michigan Central Locomotives. Describes engines designed by Robert Miller, one being built by the Schenectady Locomotive Works, and three at the Jackson shops of the Michigan Central. 1700 w. R R Gaz—June 11, 1897. No. 13380.

Ten-wheel Passenger and Fast Freight Locomotives—Chicago, Rock Island & Pacific Railroad. Data and illustrations in connection with these engines, which represent advanced locomotive design. 2000 w. Ry Rev—June 12, 1897. No. 13438.

The Use of High Steam Pressures in Non-Compound Locomotives. Dugald Drummond. From selected papers of the Institution of Civil Engineers. Describes tests made on the Caledonian Railway, to ascertain what increase of efficiency or economy is derived from raising the boiler pressure in non-compound locomotives. 3400 w. Eng News—June 10, 1897. No. 13377.

PRIVATE Cars.

Another Royal Train. Brief description of train prepared to convey the Queen from Windsor to Paddington on occasion of the long reign commemoration. 700 w. Ill Car & Build—June 11, 1897. No. 13641 A.

Private Cars. Duane Doty. Illustrated description of the De Beers private car and the car "Marion." 2000 w. R R Car Jour—June, 1897. No. 13363.

The Presidential Car. A. Richards. Suggestion for the decoration of the dining portion of the special car for the President. Ill. 500 w. R R Car Jour—June, 1897. No. 13367.

TRUCKS.

Metal Trucks for Cars of 100 000-Pounds Capacity. Description and drawings of trucks to be used under the metal cars being built for the Pittsburg, Bessemer & Lake Erie Railroad. Describes the Schoen, Fox, Kindl, Cloud, Vogt, and American Steel Foundry Company's trucks. Also editorial. 2500 w. Ry Mas Mech—June, 1897. No. 13271.

Standard Steel Truck—Mexican Central Railroad. Illustrated description of the peculiar features of the construction of a metal, diamond-frame truck designed by A. A. Robinson. 500 w. R R Gaz—June 4, 1897. No. 13305.

Steel Underframing for Freight Cars. Report of the committee submitted at the Master Car Builders' Convention. Ill. 3300 w. Ry Rev—June 28, 1897. No. 13734.

The Cloud Truck. Illustrated description of a new design consisting of a combination of plate steel side frames and malleable iron pedestals which are riveted thereto. 1400 w. Ry Rev—June 12, 1897. No. 13437.

The Present Standing of the Steel Truck. Editorial comment on design and cost. 1600 w. R R Gaz—June 4, 1897. No. 13311.

VESTIBULED Train.

The New Vestibuled Train of the Chicago, Burlington & Quincy. Illustrated description of train. The arrangement, finish and decoration of the interior is especially interesting. 1000 w. R R Gaz—June 4, 1897. No. 13308.

WHEELS.

Specifications and Guarantee for Cast-Iron Car Wheels. Report of a committee of the Master Car Builders' Assn. presented at the annual convention held at Old Point Comfort, Va. 2000 w. Eng News—June 10, 1897. No. 13379.

The Anticipation of Failure. George S. Hodgins. Considers the symptoms of a wheel malady which indicate a near approach to danger. 1500 w. R R Car Jour—June, 1897. No. 13364.

MAINTENANCE OF WAY.

CROSS Ties.

Note on the Preservation of Wooden Cross Ties. (Note sur la Conservation des Traverses en Bois.) An investigation of the economy to be realized by the use of various preservatives, based upon actual results obtained upon the French railways. 3000 w. La Revue Technique—May 10, 1897. No. 13542 D.

RAILWAY Works.

The London Works of the Great Central Railway. Illustrated description of the London structures of this road now in process of construction. 2000 w. Ry Wld—June, 1897. No. 13400 A.

STATION.

New Union Station at Montgomery, Ala. Brief illustrated description of the improved facilities for passengers and freight provided by the Louisville and Nashville Railroad. 500 w. Ry Age—June 4, 1897. No. 13322.

STEEL Rail.

The Development of the Steel Rail in the United States. H. G. Prout. Reviewing the history of the steel rail up to 1887. Ill. 4700 w. Eng Mag—July, 1897. Serial. 1st part. No. 13809 B.

SIGNALING.

SIGNALING.

Progress in Signal Engineering. Charles Hansel. Briefly reviews the early history of railways and the requirements to protect traffic, and the growth of the system, showing improvements to the present, and the effect upon the volume of traffic. Ill. 11300 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13667 D.

Quadruple Block Signal System. (Einrichtung von Blocklinen mit Viertheiligen Streckenblockwerken.) A system for obtaining greater security against rear end collisions by doubling the number of blocks between trains. 2 plates, 6000 w. Oesterr Monatschr f d Offent Baudienst—June, 1897. No. 13530 D.

TERMINALS AND YARDS.

CAR Handling.

Handling of Foreign Cars at Large Terminals. Interesting remarks in regard to errors and abuses in connection with the handling of interchanged cars at terminals. Taken from report by W. E. Beecham, chairman of a committee of the Central Western Assn. of Car Service Officers, appointed to investigate this subject. 3000 w. Ry Age—June 18, 1897. Serial. 1st part. No. 13640.

TRANSFER Table.

Transfer Table at Huntington shops—Chesapeake and Ohio Railway. Illustrated description of a transfer table in which compressed air is the motive power. 600 w. Loc Engng—June, 1897. No. 13329 C.

TRANSPORTATION.

CAPE COLONY.

The Railways of Cape Colony. A very favorable report of earnings, with account of improvements to be carried out. 1800 w. Trans—June 4, 1897. No. 13418 A.

CHEAP Transportation.

Lessons from American Railroads as to Cheap Transportation. W. R. Stirling. A paper aiming to show to what extent and how American railways have lowered their rates for transportation, and thereby cheapened the cost of raw material and manufactured commodities. Read at the annual conference of the British Trade Assn 5300 w. Ir & Coal Trds Rev—May 28, 1897. No. 13353 A.

ELECTRICITY vs. Steam.

The Application of Electricity to Steam Railroads. Paul H. Brangs. Abstract of Paper read at convention of the Master Mechanics Assn. Advocates the electrical equipment of branch lines and the use of electricity in many special cases. 1200 w. Elec Wld—June 26, 1897. No. 13750.

ENGINE Performance.

The Adjusted Car-mile as a Basis for Engine Performance. An account of tests made by the Pennsylvania lines west of Pittsburg, to determine the resistance of cars in freight trains, and investigating the practicability of applying an adjustment to the *car-mile* measurement of engine performance. 1400 w. RR Gaz—June 4, 1897. No. 13304.

EXPRESS Trains.

Our Express Trains and Locomotives. Editorial on the progress made by our express trains, and the excellence of locomotives in the United States. 1200 w. Loc Engng—June, 1897. No. 13332 C.

FAST Runs.

The Chicago-Nashville Fast Run. A record of an excellent performance. 600 w. RR Gaz—June 4, 1897. No. 13306.

A Table of Fast and Unusual Runs. Interesting table from the work "Modern Locomotives" soon to be published. 2000 w. RR Gaz—June 11, 1897. No. 13382.

MISCELLANY.

APPLIANCES.

Primitive Railway Appliances. C. B. Fairchild. Historical account of some of the early

appliances, some of which have been successful and others failures, but showing the evolutionary process of development. Ill. 2000 w. St Ry Rev—June 15, 1897. Serial. 1st part. No. 13490 C.

CHINA.
See same title under Mining and Metallurgy, Iron and Steel.

CONVENTION.
Annual Convention of the American Railway Master Mechanics' Association. An account of the meeting at Old Point Comfort, Va., with abstracts of most of the committee reports. 10000 w. RR Gaz—June 18, 1897. No. 13471.

Needed Reforms in the Railway Mechanical Conventions. Editorial comment on the reforms needed in the Master Mechanics' Assn. and Master Car Builders Assn. 1600 w. Eng News—June 24, 1897. No. 13684.

The Master Car Builders' Association. Report of the meeting at Fort Monroe, with abstracts of addresses, discussions, &c. 2000 w. R R Gaz—June 18, 1897. No. 13472.

COUPLERS.
Automatic Car Couplers for English Railways. Editorial on the slowness of Great Britain in adopting automatic car couplers, with criticism of an editorial on the subject which appeared in a recent number of the London "Engineer." 1300 w. Eng News—June 10, 1897. No. 13376.

DISPATCHER.
The Duties and Discretionary Powers of a Train Dispatcher. H. A. Dalby. Extracts from a paper read before the annual meeting of the Train Dispatchers' Assn. The things n cessa y to make the best dispatcher. 1400 w. R R Gaz—June 25, 1897. No. 13703.

EMPLOYEES.
Railroads and Employees. F. H. Stark. Considers the relation of employees on railroads to the employer. 1200 w. R R Car Jour—June, 1897. No. 13365.

FREIGHT Station.
How to Manage a Freight Station. J. F. Youse. Read before the Assn. of Officers & Junction Agents of the Columbus, Hocking Valley & Toledo R. R. Suggestions. 1100 w. R R Gaz—June 4, 1897. No. 13310.

FREIGHT Trains.
Causes and Remedies for the Parting of Railw y Freight Trains. Report of a Committee of the Master Car Builders' Assn. presented at the annual convention at Old Point Comfort, Va. 2200 w. Eng News—June 10, 1897. No. 13375.

GERMANY.
German Railway Working, 1895-96. Statistics taken from report issued by the Imperial Railw y Department. 1200 w. Eng, Lond—May 28, 1897. No. 13316 A.

ILLINOIS.
The Railways of Illinois. Dwight C. Morgan. Diagrams showing in a graphical manner the railroad conditions of Illinois for the past 25 years, with explanatory remarks. 2000 w. Ry Age—June 4, 1897. No. 13321.

JAPAN.
Opportunities for the Car Builder in Japan and China. R. Van Bergen. Discusses the probability of demand for American rolling stock in China and Japan, and how to enter into business relations with safety. 2000 w. R R Car Jour—June, 1897. No. 13366.

LEGISLATION.
Railroad Legislation in Massachusetts. A review of t e large amount of railroad legislation presented at the last session. 3000 w. R R Gaz—June 25, 1897. No. 13699.

Railroad Legislation in New York. Reviews the 15 bills affecting railroads, which have been passed during the past year. 1500 w. R R Gaz—June 25, 1897. No. 13701.

See same title under Street and Electric Railways.

SCANDINAVIA.
Notes on a Journey in Scandinavia. W. J. McCarroll. Gives information of the railroads of the country. 2400 w. Loc Engng—June, 1897. No. 13333 C.

TIME.
See same title in Marine Engineering.

TRANSCONTINENTAL Railways.
Profiles of Transcontinental Railways. Double-page engraving showing the comparative features of the several lines reaching the Pacific coast, with tables and description. 2200 w. Eng News—June 10, 1897. No. 13378.

STREET AND ELECTRIC RAILWAYS.

AIR-BRAKE.
The Howe Air-Brake for Electric Cars. Describes an air brake designed especially to meet the needs of electric street car service, but is equally applicable to cable service, and to other services running single cars or short trains. Ill. 1000 w. R R Gaz—June 4, 1897. No. 13309.

ALTERNATING Current.
See same title under Electrical Engineering, Power.

BOSTON Elevated.
The Boston Elevated Railroad. The important features of the new franchise which has recently been passed and approved by the governor, with comments by editor. Map. 2200 w. R R Gaz—July 2, 1897. No. 13816.

CAIRO, Egypt.
To the Pyramids by Electricity. Account of a projected tramway, and information of the popularity of the tramways of Cairo. Ill. 1000 w. St Ry Rev—May 15, 1897. No. 12956 C.

COMPRESSED AIR Locomotive.
The Hardie Compressed Air Locomotive for the Manhattan Elevated Ry. Illustrated detailed description. 1000 w. Eng News—June 24, 1897. No. 13683.

CONDUIT System.
The "Mapple" Hinged Conduit System. Illustrated description of a system for electric traction, in which the distinctive feature is found in the means provided for reaching the interior of the conduit without removal of the slot rails or disturbance of the paving of the

roadway. 1100 w. Ry Wld—June, 1897. No. 13401 A.

COUNTERWEIGHT System.

The Morgan Park Counterweight System. Illustrated description of various applications of this system. 2700 w. Ry Rev—May 22, 1897. No. 13111.

CURRENTS.

Stray Currents in Electric Tramways. (Zur Frage der Vagabunderen den Ströme bei Elektrischen Bahnen.) A discussion of various means of reducing the losses due to the return current through the rails. 2500 w. Die Elektrizität—April 10, 1897. No. 12773 B.

DOVER.

The Dover Corporation Electric Tramways. Henry E. Stilgoe. Read before the Incorporated Assn. of Municipal and County Engs., at Dover. Illustrated detailed description. 2000 w. Elec Eng, Lond—May 7, 1897. No. 12941 A.

EARNINGS.

The Commercial Aspect of Electric Railways. C. E. A. Carr. Discusses modes of advertising, improvements, and ways of increasing the revenue. 1700 w. Can Elec News—June, 1897. No. 13480.

ELECTRICAL Equipment.

The Cost and Advantage of Electrical Equipment for Railways. John C. Henry. Gives the results of investigations for the electrical equipment of the Florence and Cripple Creek Railway. The equipment proposed is quite a departure from the ordinary street railway practice. 2000 w. Elec Eng—June 2, 1897. No 13241.

The Electrical Equipment of Steam Roads in Chicago. Illustrated detailed description of construction and equipment, with editorial. 3500 w. Ry Rev—June 19, 1897. No. 13659.

ELECTRICITY vs. Steam.

See same title under Railroad Affairs, Transportation.

ELECTRIC Railways.

Advice to Builders of Electric Railways. G. Whitefield Chance. Calls attention to important matters in the construction and operation of interurban roads. 1400 w. W Elec—June 5, 1897. No. 13349.

ELECTRIC Traction.

Electric Railroading on the New York, New Haven & Hartford System. N. H. Heft. An outline of what this company has been doing in its electrical department during the last three years. Ill. 4800 w. St Ry Jour—June, 1897. No. 13191 C.

Some Recent Developments in Electric Traction Appliances. A. K. Baylor. Read before the Inst. of Elec. Engs. Part first discusses the modern plant, considering generators, overhead line, ground returns, and the three-wire system. Ill. 5000 w. Ry Wld—May, 1897. Serial. 1st part. No. 12940 A.

The "Walker System" of Electric Traction. Justus Eck. Read before the Tramways Institute. Pointing out the various specialties and advantages of this system. Ill. 3500 w. Elec Rev, Lond—April 23, 1897. No. 12596 A.

ELECTROLYSIS.

Electrolysis from Electric Railway Service. Arthur J. Rowland. A study of the return circuit with a view to overcoming electrolytic troubles, or to so planning a road that they will never begin. 3800 w. Am Elect'n—May, 1897. No. 12867.

EQUILIBRIUM System.

The Equilibrium System of Feeding Electric Railways. Charles Ernest Paolo Diana Spagnoletti. Describes a method of working long lines of railways by electricity. Read before the Civil Engineers' Conference. 800 w. Elec Eng, Lond—May 28, 1897. No. 13294 A.

FARE.

The Indianapolis 3-Cent Fare Law. President Mason's report reviewing the situation is given in full. 3500 w. St Ry Rev—May 15, 1897. No. 12953 C.

FRONTIER Railway.

The Lewiston and Youngstown Frontier Railway. Brief illustrated description of railway in Niagara Co., N. Y. 900 w. St Ry Rev—May 15, 1897. No. 12954 C.

INTERRUPTIONS.

How Can Interruptions in New Power Installations be Prevented? (Wodurch Können Betriebsunfälle bei Strassen bahnen Möglichst Vermie den werden?) Discussing the interruptions and breakdowns which usually accompany the early working of electric trolley lines, with means for their avoidance. 2000 w. Deutsche Zeitschr f Elektrotechnik—April, 1897. No. 13584 B.

LEGISLATION.

Steam and Trolley in the Connecticut Legislature. Clarence Deming. A review of the legislative campaign, with summary of results. 2000 w. RR Gaz—June 25, 1897. No. 13698.

Street Railroad Legislation in Indiana. Statement of the situation regarding state legislation affecting railroad rates. The three-cent fare. 1400 w. Bradstreet's—June 19, 1897. No. 13602.

MOTORS.

See same title under Mechanical Engineering, Engines and Motors.

MUNICIPAL Ownership.

Municipal Ownership of Street Railroads in England. W. M. Acworth. Gives experience in England, stating the general tramway conditions, proportion of public ownership, power of purchase, public working, etc. 3000 w. R R Gaz—June 4, 1897. No. 13312.

PARIS.

The Proposed Paris Electric Tramway System. (Die Stadtbahn von Paris mit Elektrischen Betriebe). A detailed account of the official plan for providing Paris with a complete system of electrical transportation. 2 plates, 4000 w. Oesterr Monatschr f d Oeffent Baudienst—June, 1897. No. 13528 D.

POWER Plants.

How Shall we Arrange Electric Trolley Plants with View to Further Extension? (Wie Sollen wir Unsere Elektrictätswerke Bauen?) A comprehensive discussion of the arrangement of street railway power plants, taking into account the extension to additional lines. Two articles. 10000 w. Deutsche Zeitschr f Elektrotechnik—April, May, 1897. No. 13585 E.

STREET PAVING.

Street Paving an Improper Basis of Compen-

sation for Street Railway Franchises. Editorial discussing the objections to street paving as a compensation for street railway franchises. 2500 w. Eng News—June 17, 1897. No. 13487.

THIRD-RAIL.

Insulation and Bonding of the Third-Rail Electric Conductor. H. K. Landis. Describes the construction of the new electric branch of the N. Y., N. H. & H. R. R. Ill. 1600 w. Elec Eng—June 9, 1897. No. 13337.

The Third Rail System on the New Haven Railroad. Illustrated description, with editorial. 2800 w. Sci Am—June 12, 1897. No. 13348.

TRAMWAYS.

Statistics of the Electric Tramways in Europe. (Statistik der Elektrischen Bahnen in Europa.) Giving comparative figures by countries for 1896 and 1897. The mileage has increased from 560 in 1896 to 905 in 1887, and in other respects in the same proportion. 2000 w. Die Elektrizität—May 22, 1897. No. 13567 B.

UNDERGROUND Railway.

Electricity on the London Central Underground. Describes the system of electrical equipment which is entirely American. Map. 1800 w. Elec Eng—June 30, 1897. No. 13813,

VIADUCT.

An Electric Street Car Viaduct. Illustrated description of the viaduct that carries the Consolidated Traction Co.'s electric car line on the turnpike between Jersey City and Newark over the D. L & W. R. R. Co.'s tracks. 1200 w. Eng Rec—June 5, 1897. No. 13273.

WAGONS.

Electric Repair Wagons. (Montage und Revisions Wagen für Elektrische Strassenbahnen.) Giving illustrations both of the American and German styles of wagons for making repairs to overhead trolley lines. 1000 w. Deutsche Zeitschr f Elektrotechnik—May, 1897. No. 13587 B.

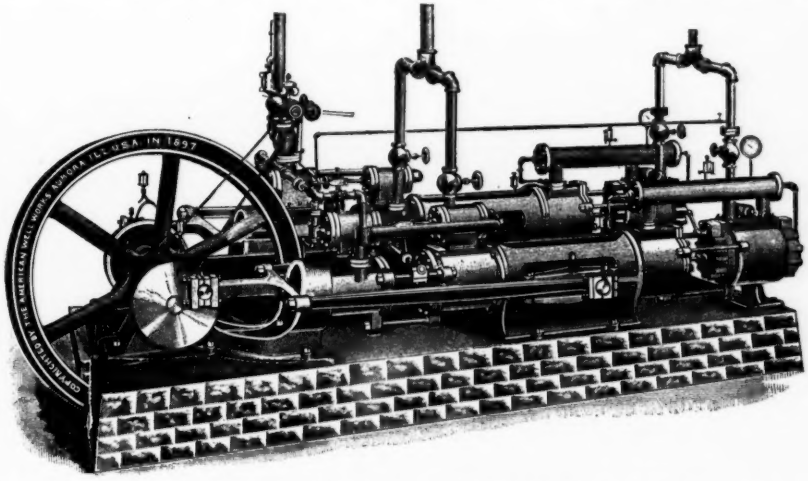
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

High Duty Compound Steam Driven Two-Stage Air Compressor.

THIS picture is made from a photograph of a high duty compound steam driven two stage air compressor for compressing air to raise and aerate water from deep wells for city water supplies, etc., economically. Its advantages are that (*a*) it economizes in the use of steam by using balanced steam supply valves; (*b*) high pressure steam is used in all of the cylinders for starting; then the steam is shut off from the large cylinders, and used expansively in the compound cylinder for continual operation; (*c*) high pressure steam is used around the compound steam cylinder to maintain a uniform heat and to save the loss of power caused by



condensation (as used in marine engines); (*d*) it is arranged for adding the condenser for further economizing in operating expenses where fuel is expensive; (*e*) it economizes in the compression of air by first compressing it to a part of the pressure required, then taking out the accumulated heat by cooling thoroughly before compressing it to a higher stage; recompressing and cooling may be continued from stage to stage until the desired pressure is reached; (*f*) the largeness of its inlet valves saves the loss generally experienced from expansion of air by heat of frictional contact in passing through a small opening; (*g*) the outlet valves have the least possible loss in opening and closing on account of the largeness of the valve openings, their quick action, and small clearance; (*h*) air can be taken from the coolest and cleanest place, and conducted in a pipe to the compressor.

It is claimed that this method of raising water saves from fifteen to fifty per cent. over the best deep well pumping engines in use, compressing air from twenty five to seventy-five per cent. cheaper than can be done in the one stage compressor.

This engine should not be classed with the ordinary compressors used in mining and for operating quarry drills where high duty is not essential, but should be ranked with high duty pumping machinery, as the engine is finished and fitted for a well appointed engine room; the balance wheels are turned true and balanced, and the material and workmanship is of the best.

By the Chapman air-water lifting process, air is forced down the central pipe to a sufficient depth in the water, then up through the ejector on the lower end of the central pipe, lifting the water by

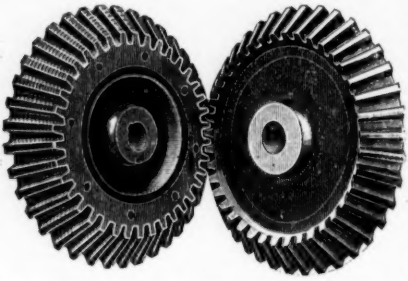
its force. The air expands as it nears the top, and is finally forced out with great velocity. It is claimed that it will lift from the same sized well, two to five times more water than can be gotten by any deep well pump, with a loss for friction of the air lifting the water guaranteed in no case to exceed more than fifteen per cent., and with much less expense for fuel and labor. Others use the expansion of air only ; the Chapman process uses first, the force, then the expansion, thereby enabling water to be lifted to greater heights.

When it is required to bring water a long distance from a river, etc., the duplex in-take is placed on the bank of the river, either above or below water, and pipe connections are made between the compressor and the in-take. The latter is not only duplex, but automatic. It is filled by suction, and the water is discharged by force to any distance or elevation.

This pump is manufactured by the American Well Works, Aurora, Ill., Chicago, Ill., or Dallas, Tex.

New Process Raw Hide Gears.

THE accompanying engraving illustrates a pair of gears recently made by the New Process Raw Hide Company, 248 West Railroad Street, Syracuse, N. Y., U. S. A., for the United States government. One of this pair of gears is of cast iron, the other of raw hide prepared by a process peculiar to the company above named. Under this process the raw hide is made hard and dense, somewhat resembling horn in external appearance,



and nearly, or quite, as strong and durable as cast iron. A peculiarity of this material which gives it great value in the industrial arts is its insonorous quality. When struck by, or struck against, another hard body, scarcely any sound is produced. This property, together with its hardness and durability, has given the material a large and increasing use in high speed gearing, which, if made wholly of metal, is apt to make a very annoying and unwelcome kind of music. In the use of electric motors of small size, running at high speed, it is necessary at times, when positive motion is required, to speed down with spur or bevel gearing. In such cases, if one in each pair of wheels be made of "New Process" raw hide, the train of gearing may be made to run almost inaudibly. In any case of a noisy gear and pinion, the substitution of a raw hide pinion will render the operation practically noiseless. The "New Process" raw hide is also used for other purposes, such as bushings, washers, reinforcing or binding mallets, chisel handles, etc. The pair of wheels illustrated are 18.143 inches in diameter, 3-inch face, 1½ inch pitch, and have 38 teeth. Pinions of very small size, say from ¾-inch to 1¼-inch pitch line diameter, may be made, and they work very nicely. We have seen very high-speed electric motors thus speeded down with good results.

An Important Contract.

THE St. Lawrence Construction Company, of New York, has recently awarded to the Westinghouse Electric and Manufacturing Company a contract for fifteen 5000-h. p. generators, to be erected at their plant at Massena, northern New York. This is the largest single order ever given for electrical apparatus, and the amount directly involved is about three-quarters of a million dollars. This contract, together with that recently given by the Cataract Construction Co. of New York, for five 5000-h. p. generators, for installation at Niagara Falls, N. Y., makes a total of twenty 5000-h. p. generators, having a total capacity of 100,000 h. p., which have been ordered from the Westinghouse Electric & Mfg. Co., this year. The five generators for Niagara Falls are well under construction, and the other fifteen, required by the St. Lawrence Co., will be immediately proceeded with. Their construction will give employment to a large number of men. The placing of these important contracts has undoubtedly resulted from the great success of the three 5000-h. p. generators already installed at Niagara Falls by the Westinghouse Electric & Mfg. Co.

The Strange Forged Twist Drill.

THESE drills are made by forging. The twist and groove are simultaneously hammered into them at a proper red heat, and it is claimed that they will do one-third more work than the old style twist drills. It is asserted that these drills will hold their edge as persistently as any forged lathe or planer tool, and that they possess the maxi-

mum strength of the material. A demonstration, free of charge, is offered to anyone who will, by mail or otherwise, request it of the manufacturers, the Strange Forged Twist Drill Company, New Bedford, Mass.

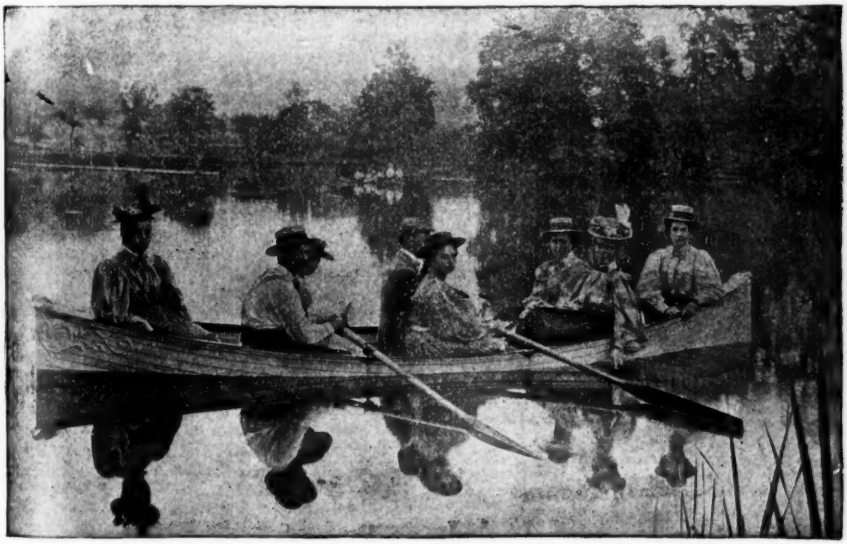
Stamped and Embossed Sheet Metal Double Ender Rowboats.

THE engraving illustrates one of a line of boats made by an entirely unique process. They are formed by stamping metal plates in large and expensive dies, immense and very accurate drop presses being used for this purpose. These plates, of which there are only 8 to the largest boat, are then riveted and doubled-seamed together, making the strongest, lightest and most durable boat ever devised; one that will not crack open or become leaky when exposed to the weather, or waterlogged and heavy when in use. This method of manufacture is the invention of Mr. W. H. Mullins, a manufacturer of architectural sheet metal work and statuary at Salem, Ohio, U. S. A. At present he has ready for the market two styles of these metal boats, the one which he calls the "Double Ender" row-boat, 15 feet long 42 inches beam, 25½ inches at ends and 14 inches amidship, shown in the cut, and the "Get There" safety ducking boat, 36 inches wide, 11 inches high to top of deck, 14 inches high to top combing. The materials used are galvanized steel, manganese bronze, and aluminum. Many testimonials to the merits claimed for these boats have been received by Mr. Mullins.

THE STRANGE FORGED TWIST DRILL.

Transmission of Power Eighty Miles.

A CONTRACT for the transmission of power of the river running through the Santa Ana Cañon to Los Angeles and Pasadena, has been concluded between the Southern California Power Co. and the General Electric Co. The amount of power to be transmitted at first is four thousand horsepower. The station will be located in the Santa Ana Cañon, twelve miles from Redlands and about eighty miles from the towns in which the electric power will be utilized. The water will



STAMPED AND EMBOSSED DOUBLE ENDER SHEET METAL PLEASURE BOAT.

be taken from the river through canal, flume, and tunnel along the side of the cañon. Here it will be led into a pipe line 2,200 feet long, giving what will be equivalent to a vertical fall in the water of 750 feet. The wheels will be of the impact type, directly connected to the generators. There will be four of these wheels, each of 750-kilowatt (1,000 h. p.) capacity. The maximum line potential will be 33,000 volts, to which potential the initial voltage will be raised by twelve 250-K. W. step up transformers. This transmission will be the longest commercial electrical power transmission yet undertaken, as well as that using the highest voltage. At present the longest is that transmitting the power of the waters of the Ogden Cañon in Utah to Salt Lake City, a distance of 36 miles. The Los Angeles transmission will be more than twice that distance, and three times the longest distance yet tried with the power of Niagara, which to date has been transmitted only to Buffalo, a distance of twenty-six miles.

Fire-Proofing.

THE New York & Staten Island Electric Company are erecting at Livingston, Staten Island, a new power house of modern construction. The walls of the building are brick, and the roofs have steel trusses covered with corrugated iron. The roofs are arranged with suitable monitors, with skylights for light and ventilation. On the building is a large wire tower of steel construction. The engine room is arranged for a travelling crane of thirteen tons, capacity. The building has been constructed with the idea of having it absolutely fireproof, and arranged in an up-to-date manner. The roof of the engine and dynamo portions of the building is lined underneath the corrugated iron with the Berlin Iron Bridge Company's "Anti-Condensation" fire-proof roof lining. The Berlin Company, East Berlin, Conn., have the contract also for furnishing and erecting all the steel framework and the covering for the plant.

THE Detroit Graphite Mfg. Co., of Detroit, Mich., has recently acquired the title to the graphite mines in Northern Michigan from which they have been making their Superior Graphite Paint. The ore from this mine produces the best pigment for paint so far found. This pigment is reduced to a fineness never before obtained from graphite, and none of the graphitic carbon is taken from it to be used for other purposes. It is unassailable by acids, or chemicals of any kind, and is of an absolutely uniform quality. The Superior Graphite Paint made by this Company has obtained an enviable popularity.

NEW CATALOGUES.

Cahall Sales Department, Pittsburgh, Pa., U. S. A.=Illustrated pamphlet entitled "Big Boilers," in which the merits of the Cahall system of boilers, where headroom enough is available, and of the Babcox & Wilcox type (as manufactured by The Aultman and Taylor Machinery Co.), where there is too little headroom for vertical tubes, are set forth in a forcible and convincing manner, and in which facilities for manufacturing in the most approved style of the art, and in almost unlimited quantity, are stated.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A. (Burnham, Williams and Co.)=Circular illustrating and describing the exhibit of the Baldwin Locomotive Works at the Tennessee Centennial and International Exposition.

Pneumatic Engineering Company (Incorporated), New York=A beautiful pamphlet (half-tone illustrations). A manual setting forth the features of the business of this company, which consists in the supply of machinery for air-lift pumping.

Variety Machine Company, Warsaw, N. Y., U. S. A.=Catalogue of the "Rochester" hay-carriers and slings.

Builders' Iron Foundry, Providence, R. I., U. S. A.=(*a*) Part II of essay entitled "Our Share in Coast Defence," giving extracts from government specifications and reports relating to the 12 inch breech-loading rifled mortars made at these works, (*b*) Part III of same essay, giving a full illustrated account of the spring return mortar carriages used for mounting the above named 12-inch rifled mortars.

W. S. Rockwell & Co., New York.=Pamphlet describing features of their business as furnace engineers, designing and erecting furnaces, for oil, gas, coal, or wood fuel, adapted to different manufacturing purposes.

Fred H. Nichols, Lynn, Mass., U. S. A.=Leaflet illustrating and describing Nichols "Perfect" safety gate for grade crossings.

New York University, New York.=(*a*) Announcements for the "University College" for 1897–98. (*b*) Annual circular of the New York University School of Engineering.

Purdue University, La Fayette, Ind., U. S. A.=Annual catalogue for 1896-97, with announcements for 1897–98.

Lamson Consolidated Store Service Company, Lowell, Mass., U. S. A.=Pamphlet containing illustrated description of pneumatic tube apparatus for transmitting packages and cash to and from sales counters and cash-rooms.

The Hayden & Derby Manufacturing Company, New York.=Illustrated catalogue and price list of "Metropolitan" injectors and "H-D" injectors.